THE ILLUMINATING ENGINEER

LIGHT
LAMPS
FITTINGS
AND
ILLUMINATION

THE JOURNAL OF

GOOD LIGHTING

Official Organ of the Illuminating Engineering Society

FOUNDED IN LONDON 1908

Edited by
LEON GASTER

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ELECTRICITY
ACETYLENE
PETROL-AIR
GAS
ETC.

Vol. XX

December, 1927

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Special Features:

Progress in Illuminating Engineering (Opening Meeting of the Illuminating Engineering Society)—The Natural Lighting of Picture Galleries—Street Lighting and Public Safety—Street Lighting regarded as an Illumination Problem—The Street Lighting of London—Report of the Committee on Street Lighting of the American Illuminating Engineering Society—News from Abroad—Correspondence, etc.

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The Illuminating Engineering Society Opening Meeting

THE opening meeting of the Illuminating Engineering Society on November 22nd as usual afforded an opportunity for a survey of recent progress in illumination. The chief feature of the Report of Progress was the account of conferences and meetings abroad, and the gatherings of the delegates of the International Illumination Commission at Bellagio. The aims and objects of the Commission have now been ably presented in an official report, and it is hoped that this will assist in making its useful work more widely known.

The recent developments in co-operation between the National Illumination Committee and the B.E.S.A. are also of considerable importance. The fact that it has been found possible to introduce standardization in illuminating engineering is a sign of progress, and at recent meetings of the Illuminating Engineering Society due credit has been given to the members of the various B.E.S.A. committees and of the committee working under the Department of Scientific and Industrial Research, who, in an honorary capacity have done a great deal of exceedingly useful work, of considerable benefit to the lighting industry.

In conversation with lighting experts from other countries the writer has found that all of them were impressed by the activity of the various organizations for research in his country, and especially by the judicious methods by which they are linked together. The distribution of work amongst different committees and organizations is a healthy sign and a natural development. It is, of course, important that all research and propaganda should be co-ordinated, and it is here that the Illuminating Engineering Society has played such a useful part. Another, and undoubtedly one of its chief functions, is the provision of an impartial platform where all reports and developments can be presented and discussed, and brought to the notice of a wider circle of people than would otherwise be possible. A third service rendered by the Society is in acting as a clearing house for information from abroad, and promoting interchange of experience between experts in different countries. The Illuminating Engineering Society, with the aid of its official organ, is in a very favourable position to help in this respect.

The Report of Progress indicates how the activities of illuminating engineering societies in other countries are developing. It is essential that lighting experts in this country should be kept informed of these developments; and that this country should possess a powerful and independent Illuminating Engineering Society capable of expressing the national view. We hope that individual members will do all in their power to strengthen the position of the Society. They can do so in many ways—by helping to make known its work when they read papers or deliver lectures before other societies or public bodies, by sending in to the journal particulars of developments in lighting that ought to be generally known, and by inducing others to join the Society and share in the good work it is doing.

We especially emphasize the latter point. Our Illuminating Engineering Society is the oldest in Europe, and it ought to be the strongest. An interesting series of papers and discussions has been arranged for the session just started, and other informal meetings and visits are being arranged. The Society can do much to help the lighting industry and members individually, but the extension of its work demands a considerable increase in its existing membership and financial support.

The opening meeting also afforded an opportunity for the presentation of two useful reports summarizing progress in gas and electric lighting. Whilst there are no very radical departures or sensational inventions to record, there can be no question of the steady progress effected in matters of detail, and of the persevering education efforts in favour of better lighting. The lighting industry itself is now supplementing the efforts of the Society by energetic propaganda. This again, is an entirely legitimate and welcome step. The Illuminating Engineering Society has always recognized that the field is too vast to be dealt with completely and directly by its own efforts.

There are some forms of propaganda work, such as that involved in connection with Government departments and matters of public policy, where an appeal from an independent scource is essential for success. But the opportunities of influencing the public open to manufacturers and supply undertakings are vast. The latter, by reason of their close and intimate relations with the public have special opportunities—as was illustrated in the paper recently read by Mr. W. J. Jones at the E.D.A. Conference on October 21st.

We look forward to the day when every supply undertaking, gas or electric, will have on its staff engineers trained in the principles of illuminating engineering and capable of giving effective advice and service to the public in the design of lighting installations.

There is work for everyone, provided it is conducted in accordance with accepted principles and a common policy—so that the same good advice may reach the public from many different directions. We are glad to observe that the programme for the session includes a prospective discussion on "The Illuminating Engineering Movement at Home and Abroad," when all these aspects of the situation can be fully discussed.

The Natural Lighting of Picture Galleries

THE natural lighting of picture galleries, which is discussed in Technical Paper No. 6 issued by the Department of Scientific and Industrial Research,* presents many interesting problems. Some account of researches conducted at the National Physical Laboratory for H.M. Office of Works was given in a paper before the Illuminating Engineering Society a few years ago. It was then pointed out that the provision of adequate illumination and the design of the distribution of light is only a part of the problem. One of the most difficult questions is the avoidance of troublesome reflections from the glass protecting pictures, or from their shiny surfaces when uncovered. This is one of the chief points discussed in the present report of the Illumination Research Committee, which is illustrated by many beautiful photographs.

One of the main principles to be adopted in avoiding such reflections is to ensure that whilst the pictures are amply illuminated, no direct light reaches the spectators in their normal positions in the gallery. In a two-sided gallery a screen may be eretced along the whole length of the room to avoid cross-reflections. But the most perfect results are obtained in a one-sided room of special design, such as that adopted in the National Gallery, Millbank, which is admirably illustrated in the report. The Committee have also reached the conclusion that a daylight factor (still ratio) of about 7 per cent. of the picture represents a satisfactory standard of daylight illumination. This, one gathers, is not difficult to attain by careful design.

The next point of interest is the spectral composition of light entering the gallery. The glass of windows in front of the pictures should be practically colourless so that colours may not be distorted; for the same reason wall-decorations, etc., should be natural in tone so that there is no appreciable admixture of light coloured by reflection. This last point is of considerable importance as it is usual for pictures to receive quite a considerable proportion of their light by reflections from roof, walls or surroundings.

There remains a final and difficult question—the fading effect of light on the pigments of pictures. This is an intricate problem which is now being investigated. It is remarked in the report that "the most harmful rays in producing fading are generally supposed to be those in the blue-violet, violet, and especially the ultra-violet." No doubt moisture and the nature of pigments also play a part. A variety of glass which, whilst completely colourless, is impervious to ultra-violet light, would be useful, but so far as is known no variety of glass completely meeting these requirements is known. An ingenious artifice, the use of alternate strips of green and orange glass for the windows of the Raphael Cartoon Gallery at the Victoria and Albert Museum, is described in an appendix. The resultant illumination is deficient in the ultra-violet and blue-violet regions of the spectrum and was expressly adopted with a view to preventing fading. The absorption of light is, however, considerable, and it is also evident that considerable judgement is necessary in applying this method if reasonable resemblance to the colour of normal daylight is to be obtained.

* "The Natural Lighting of Picture Galleries" (Illumination Research, Technical Paper No. 6), issued by the Department of Scientific and Industrial Research; available from H.M. Stationery Office, Adastral House, Kingsway, London; 1s. 6d. net.

Street Lighting and Public Safety

THE recent meeting of the Public Works, Roads and Transport Congress afforded another opportunity of dealing with the problem of street lighting. Two useful papers on this subject were read by Dr. J. W. T. Walsh and Mr. W. J. Jones. We are glad to see two members of the Illuminating Engineering Society bringing the claims of good lighting before other bodies. Both papers were of considerable interest.

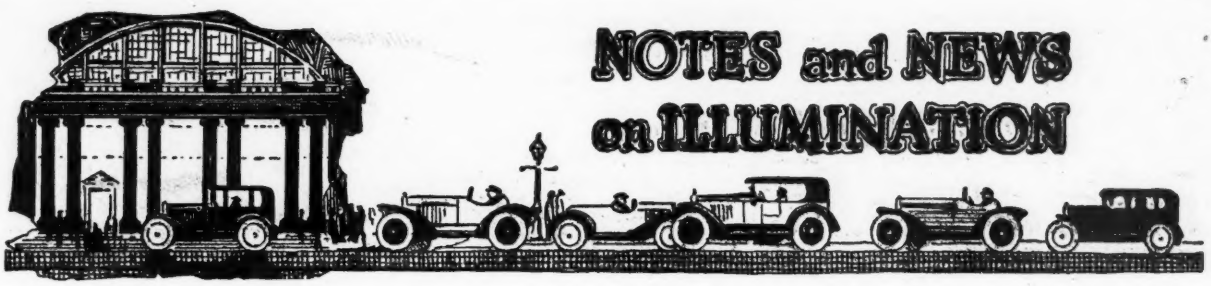
For the moment we do not propose to discuss the various technical problems raised in these papers. We would rather deal with several matters of principle, which were raised at the Conference of the Institution of Public Lighting Engineers at Brighton, and have, in the past, been dealt with at various meetings of the Illuminating Engineering Society.

The first of these points is the question of the relation of lighting conditions to street accidents. As far back as January, 1918, the writer, in a paper before the Illuminating Engineering Society, emphasized the importance of careful tabulation and classification of accidents in order that the part played by inadequate lighting might be traced and defective conditions remedied. On several occasions we have quoted evidence from various sources which suggests that lighting is a most important factor, though the basis on which returns of accidents are at present made in this country renders it difficult to draw definite conclusions. It appears, therefore that one of the first steps should be an official enquiry into the causes of fatal street accidents, similar to that already carried out in the case of fatal accidents on railways. Evidence regarding the number and nature of accidents caused by bad lighting is one of the strongest arguments that can be put forward, as a basis for Government action.

This leads us to the second point—the central supervision of public lighting. In dealing with the lighting of London in a paper before the London Society shortly before the war, the writer urged that public lighting should now be regarded as a national and not a parochial matter. The great growth in the speed and volume of motor traffic since the war has rendered such a step even more desirable than in the past. Central control was also suggested by Mr. Cramb at Brighton, and again forms one of the chief recommendations in the paper by Mr. W. J. Jones, referred to above.

It may be pointed out that this country has already had experience of central control. During the war uniform principles were laid down by the authorities as a precaution against hostile action and were willingly accepted as being in the national interest in spite of the inevitable public inconvenience involved in the restrictions imposed. Why should it not be possible, in times of peace, to attain some degree of uniformity in public lighting, by means of a permanent central advisory committee whose efforts would be directed, not towards the restrictions of lighting but to its improvement?

The constitution and functions of such a central organization would naturally require very careful consideration. For the moment what is desirable is that a Departmental Committee of Enquiry should be appointed to survey the whole question of street lighting, with special reference to its bearing on the causation of street accidents, and to report on the steps to be taken in the future.



Illuminating Engineering Society

(Founded in London, 1909).

OPENING MEETING AND PROGRAMME.

We give elsewhere an account of the opening meeting of the Illuminating Engineering Society, which was held at the E.L.M.A. Lighting Service Bureau on November 22nd. On this occasion the reports contained evidence of considerable progress in illuminating engineering, and as usual there was a comprehensive display of interesting recent lighting appliances.

We give below the provisional programme of meetings for the session. It will be observed that additional meetings and visits are contemplated, but the list already presented covers a wide range of subjects which should afford material for interesting discussions.

PROVISIONAL PROGRAMME OF MEETINGS FOR SESSION 1927-1928.

1927.

Nov. 22—Opening Meeting (Reports of Progress, etc.).

Dec. 13—Paper on "An Investigation of Electric Lighting in the Engineering Industry," by J. L. H. Cooper, B.A., A.M.I.Mech.E., A.M.I.E.E.

1928.

Jan. 24—Discussion on Various Problems in Illuminating Engineering.

Feb. 10—Annual Dinner.

Feb. 28—Inspection of E.L.M.A. Lighting Service Bureau, Address by Mr. W. E. Bush reviewing the Activities of the Lighting Service Bureau, illustrated by demonstrations.

Mar. 13—A Paper by Dr. S. English, dealing with "The Manufacture and Properties of Glass and their Application to Illuminating Engineering."

Mar. 27—A Discussion on Various Aspects of Street Lighting.

April 24—Discussion on "How Far is it Desirable to Imitate Daylight in Artificial Lighting Installations?"

May 22—Annual Meeting, to be followed by a Discussion on "The Illuminating Engineering Movement at Home and Abroad."

(Informal meetings and visits on intermediate dates are also being arranged, and notice of these will be given to members in due course.)

(Attention may be drawn to the additional paper by Dr. S. English, which has been fixed since the provisional programme was circulated amongst members, but is included in the list presented above.)

NOTICE OF NEXT MEETING

The next meeting of the Illuminating Engineering Society will be held at the E.L.M.A. Lighting Service Bureau (15, Savoy Street, Strand, London, W.C.), at 6 p.m., on Tuesday, December 13th, when a paper entitled "An Investigation of Electric Lighting in the Engineering Industry" will be read by Mr. J. L. H. Cooper, B.A., A.M.I.Mech.E., A.M.I.E.E.

The chair will be taken by the President (Mr. D. R. Wilson), and the discussion will be opened by Mr. E. A. R. Werner (H.M. Superintendent of Factories in Birmingham). Copies of the paper may be obtained on application to the Hon. Secretary (Mr. L. Gaster, 32, Victoria Street, London, S.W.1).

The Lighting of Printing Works

At a recent meeting of the Edinburgh Commercial Printers' Association in Edinburgh a lecture on "Lighting for Efficiency in Printing Works" was delivered by Mr. H. E. Hughes, District Engineer of the Scottish Lighting Service Bureau. Mr. Hughes emphasized the importance of good lighting as an aid to efficiency, endorsing his remarks by quotations from the report of the Illumination Research Committee on this subject.

The Lighting of House Numbers

We have several times referred to the movement abroad for making the lighting-up of numbers and names of houses a general practice. It is obvious that we have here a need which can be quite simply satisfied, and would remove a great deal of public inconvenience. To the taxi-driver, clearly defined luminous numbers would be an absolute blessing.

In some cities abroad it is proposed to make the lighting-up of numbers compulsory. But a very practical instance of "self-help" in this matter is to be found in Germany, where local associations for the encouragement of house-number lighting have been formed. We should not suggest that this is a special phase of illuminating engineering requiring the services of a new society. But the project in Germany is something different from this, and resolves itself into a practical commercial project in which the public, the local gas or electricity supply undertaking, and electrical constructors are all interested. Briefly, the proposal is to form a special company to furnish standard lanterns with the numbers of houses inscribed on them, and to install these in porches or front gardens, so that they can be easily seen from the road. Lanterns will be supplied with current from the road, and will be lighted up and extinguished simultaneously with public lamps. The company will also undertake the maintenance of the lights, so that the public householder is freed from all responsibility in the matter. It is anticipated that the charge for these services (including both cost of electricity or gas and maintenance) will not exceed about 3s. per house per month—by no means an excessive amount when divided between the occupants of a home. To the householder the step would be of obvious benefit. To the supply undertaking it furnishes a useful and mainly "off-peak" load, and to lamp makers and contractors it is also remunerative. We commend the idea to the enterprise of local electrical and gas undertakings in this country.

Baseball by Night

Reference was recently made in this journal to the use of artificial light for exhibitions of lawn tennis. It is worth noting that in the United States baseball has also been not infrequently played by artificial light. A recent instance was the floodlighting of the large arena at Lynn, Mass., for a contest between the Salem and Lynn teams of the New England League. The arena occupies about 80,000 square feet. The illumination was effected by six towers, each carrying twelve 1,500-watt projectors. An illumination of about 6 foot-candles was obtained. Out of the total of 72 projectors 25 were directed upwards, furnishing 135,850 lumens to enable the flight of the ball upwards to be seen. The ground received 889,200 lumens. It is stated that the lighting answers its purpose very well, even high balls being easily visible.

Conference on Light and Heat in Medicine and Surgery

The attention of readers is invited to the above conference, which is to be held at the Central Hall, Westminster, during December 13th–16th. The proceedings should be of considerable interest. Tickets may be obtained on application to the organizers (*The British Journal of Actinotherapy*, 17, Featherstone Buildings, High Holborn, London, W.C.1).

The International Illumination Commission

A USEFUL REPORT.

In referring to the proceedings at the meeting of the International Commission on Illumination at Bellagio last month we mentioned that an official report was being prepared which, it is hoped, will serve to make the aims and objects of the Commission more widely known. This report is now available, and copies may be obtained on application to the Secretary of the Commission at the National Physical Laboratory (Teddington). The report is excellently edited and produced. Following a list of officers and members, there is a brief historical account of the origin of the Commission, which came into existence as a result of the resolution passed at the Turin Electrotechnical Congress in 1911. Next there is a general summary of the proceedings at Bellagio and of the activities of the chief committees formed, which now constitute quite an imposing list. Finally we have lists of papers and communications (46 in number) presented at Bellagio, and of the names of the delegates. It will be recalled that the complete representation of different countries was one of the chief features of the Bellagio meeting, delegates from 11 different nations being present, as well as representatives of the Union of Soviet Socialist Republics and of the International Labour Department of the League of Nations at Geneva.

Hygienic Requirements of Good Lighting

In our last number we referred to the proceedings at the recent annual meeting of the German Illuminating Engineering Society, when papers by several medical men were read. Several of these papers have now appeared in *Licht und Lampe*. Special interest attaches to the contribution by Dr. Franz Schutz, who emphasizes the important part played by *contrast* in lighting. When the contrast is good (e.g., black objects against a white ground) illuminations exceeding 40 lux (approximately 4 foot-candles) add little to the powers of the eye, but if the contrast is poor very much higher illuminations may be needed. Dr. Schutz proposes values for illumination in general accord with the experience of lighting experts. Thus he suggests that reading and writing can usually be done in comfort with 5 to 6 foot-candles, and the minimum should be 3 foot-candles. Fairly fine work requires 4 to 6 foot-candles; exceptionally fine work up to 25, with a minimum certainly not less than 5 foot-candles. Another paper, by Dr. F. Holtzman, discusses the highly debatable question of the origin of myopia. He inclines to the modern view that the primary cause is hereditary, though perseverance in close work may accentuate a predisposition. The main cause of miners' nystagmus, he suggests, is inadequate illumination, though here again any inherent predisposing weakness is of great importance, and unusual movement of the eyes, arising from the miner's position, may have some influence. Dr. F. Holtzman affirms the belief that snow-blindness is due mainly to the ultra-violet rays, though (as injuries caused by incautious observations of the sun during eclipses have shown) exposure to intense glare may have a permanently prejudicial effect on vision.

Needless to say the exposure of bright unscreened sources of light within the range of vision of workers is also to be deprecated, as apart from possible injuries to eyesight, it adds to the strain of carrying on work and is a factor in causing industrial fatigue.

News from India

We were much interested to receive from Dr. Conor O'Malley, one of the corresponding members of the Illuminating Engineering Society in Ireland, a copy of an address recently given by him at the Intermediate College of Moga, in the Punjab. Dr. O'Malley assures us that Moga is by no means the typically backward village, being the centre of the activities of a celebrated Indian ophthalmic surgeon, Dr. Mathra Das. Although methods of lighting are, of course, primitive, the educated classes are keenly interested in the subject. India, in fact, is ripe for propaganda in illuminating engineering. Dr. O'Malley's address emphasized the vital importance of good illumination in the interests of eyesight, and referred in sympathetic terms to the work of the Illuminating Engineering Society. He particularly mentioned recent work done in connection with the improvement of factory lighting. After a general discussion on the principles of good lighting Dr. O'Malley turned to conditions in India, remarking that he did not understand the real meaning of glare until he walked across the baked, yellow, shadeless places in the noonday sun in the Punjab! It was a mystery how day-long toilers in the fields could stand the glare, and without any effort to protect their eyes. The great prevalence of cataract in India was doubtless partly due to the combined effects of glare and dust. Eye troubles are widespread. No doubt lack of attention to the eyes is partly responsible. But experience seems to show that even natives are not impervious to the effects of dazzling sunlight, and that protection is needed against excess of natural as well as artificial light.

Spectacular Lighting by Ultra-Violet Rays

A novel and unusual spectacle was arranged in connection with the Associated Edison Illuminating Companies' Convention at Colorado Springs. The sunken garden of the Boadmoor Hotel was floodlighted by a dozen powerful searchlights—which, however, were quite distinct from the ordinary floodlighting projector in that they furnished invisible ultra-violet rays instead of visible light. The equipment was installed by the Incandescent Lamp Division of the General Electric Company of America. Quartz-tube mercury-vapour lamps were the chief sources of invisible light, the rays being filtered through special lenses of Corning glass designed to transmit ultra-violet but obstruct the visible light. This glass also obstructs the extreme short-wave energy which, whilst not contributing greatly to fluorescence, may have a possible injurious effect on the eyes. In place of silvered-glass reflectors, which absorb ultra-violet rays, reflectors of polished aluminium, which reflect about 45°, were substituted.

In order to complete the arrangements, flowers, shrubbery and evergreens were sprayed with chemicals (such as zinc sulphide, eosin, rhodamine, etc.), capable of fluorescing under the ultra-violet rays. This gave a beautiful effect, each individual leaf, twig or flower glowing in various colours. The water of the fountain in the centre of the garden was likewise treated with luminescent chemicals, so that it sparkled in the beams of the invisible light. Furthermore, so that the guests could participate in the display, souvenirs treated with fluorescent materials were distributed and worn by the guests, and these, too, shone with coloured light as soon as they entered the magic garden.

TECHNICAL SECTION

COMPRISING

Transactions of The Illuminating Engineering Society and Special Articles

The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.

Progress in Illuminating Engineering

(Proceedings at the Opening Meeting of the Illuminating Engineering Society, held at the E.L.M.A. Lighting Service Bureau, 15, Savoy Street, Strand, London, W.C., at 7 p.m. on Tuesday, November 22nd.)

THE opening meeting of the Illuminating Engineering Society was held at the E.L.M.A. Lighting Service Bureau (15, Savoy Street, Strand, London, W.C.), at 7 p.m., on Tuesday, November 22nd, the PRESIDENT (Mr. D. R. Wilson) in the chair.

The minutes of the last meeting having been taken as read, the HON. SECRETARY (Mr. L. Gaster) read out the names of applicants for membership, which were as follows:—

Ordinary Members—

Briggs, W. T. .....Chief Electrical Engineer, Egyptian State Railways, Cairo, Egypt.

Broom, F. W. .....Electrical Engineer, 42, Regina Road, Finsbury Park, London, N.4.

Gulland, W. D. .....Manager, Private Lighting Department, Manchester Corporation Gas Department.

Podmore, A. V. .....Messrs. A. E. Podmore & Co., 34, Charles Street, Hatton Garden, London, E.C.

Stockwell, E. W. .....Electrical Engineer, Messrs. Falk, Stadelmann & Co. Ltd., Farringdon Road, London, E.C.

Associates—

Agren, E. M. .....Managing Director of the Swedish Lighting Service Association, 5, Sturegatan, Stockholm, Sweden.

Audinarayana, A. .....Electrical Engineer, Indian Leaf Tobacco Co. Ltd., Chirala, India.

Kennard, A. J. .....Public Lighting Department, Corporation of London.

Lautman, C. W. .....Messrs. Lautman & Pank, 75, Rundle Street, Adelaide, South Australia.

Pank, H. G. .....Messrs. Lautman & Pank, 75, Rundle Street, Adelaide, South Australia.

The HON. SECRETARY also recalled that, during the gathering of the International Commission on Illumination at Bellagio, many of the delegates from the various countries had shown great interest in lighting developments in England, and expressed their willingness to become corresponding members of the Illuminating Engineering Society. The list of those whom it was proposed to nominate as corresponding members would now be read, and there was no doubt that their addition would prove most useful in enabling the Society to be kept in touch with progress abroad.

Corresponding Members—

Austria.....Dr. Koch, Osram Co., Vienna.

Belgium.....M. M. Vink, Philips' Lighting Service Bureau, Brussels.

France.....M. T. Janet, Director of the Laboratoire Central d'Electricite, Paris.
M. M. Leblanc, The "Hewittic" Co., Paris.
M. de Valbreuze, Paris Electrical Supply Service.

Germany.....Dr. W. Dziobek, Reichsanstalt, Charlottenbourg.
Prof. E. Gehrcke, Reichsanstalt, Charlottenbourg.
Herr W. Wissman, Siemens Schuckert Co., Berlin.

Italy.....Prof. U. Bordoni, Royal College of Engineering, Rome.
Sig. C. Clerici, Director of the Edison-Clerici Co., Milan.
Prof. C. Montu.
Sig. G. Peri, Chief Engineer to the City of Turin.
Sig. G. Semenza, President of the International Electrotechnical Commission and Vice-President of the International Commission on Illumination.

Japan .....Dr. H. Tanaka, Japanese Imperial Railways.

Switzerland.....M. E. Binkert, Swiss Institution of Electrical Engineers.
M. E. Payot, Manager of the Bale Electrical Supply Department.
M. W. Trub, Manager of the Zurich Electrical Supply Department.

United States of America.
Dr. F. B. Meyer, Bureau of Standards, Washington.

The HON. SECRETARY also read out the names of corresponding members presented at the last meeting, who were formally declared members of the Society.

The CHAIRMAN then called upon Mr. L. GASTER to present a Report of Progress during the Vacation, which was as follows:—

A Summary of Progress during the Vacation

By L. GASTER, F.J.I.

In presenting this customary record of progress during the vacation, I have again many interesting things to record, showing that members of the Society are by no means inactive during the summer months, and that this period has been marked by steady progress in illuminating engineering.

Industrial Lighting.—There have been a number of important congresses and meetings both at home and abroad, and several reports dealing with illumination have appeared. In the report of the Council presented at the annual meeting on June 21st reference was made to the continual progress in industrial lighting and to the prospect that the Bill for consolidating and amending the Factory Act will provide for adequate and suitable lighting in factories. It was also mentioned that the equipment of the Industrial Museum in connection with the Home Office, which will contain exhibits illustrating the principles of good factory lighting, was

nearing completion. It is understood that this exhibition will be formally opened in the near future.

Further evidence of the general improvement in factory lighting was contained in the report of H.M. Chief Inspector of Factories for 1926. Various problems met with in factories were discussed and remedies described, and attention was drawn to the important part played by the vision of operators in determining quality of output. Lighting requirements and condition of eyesight are closely related. Good lighting is doubtless specially necessary in the cases of persons with subnormal vision. But if the standard of vision is unduly low the use of eyeglasses or magnifying glasses may be necessary before the benefits of better lighting can be utilized.

In the report of H.M. Chief Inspector of Factories attention was drawn to the general rise in the standard of illumination, values much higher than those considered requisite in the past being now often provided. But it is necessary to emphasize the fact that higher illuminations alone will not suffice unless other requirements, such as absence of glare and inconvenient shadows, are satisfied. This point was well illustrated in an account of some investigations in a textile mill recently communicated by Mr. Arthur Brainard to *The Electrical World*. In this case the provision of a much higher illumination was accompanied by an actual diminution in output, owing to the fact that glare and undue contrasts were introduced. Ultimately the avoidance of troublesome shadows was found to be the most important factor in this class of work.

The question of the influence on fine work of the *quality*, as distinct from the *intensity*, of illumination is still receiving attention from the Illumination Research Committee working under the Department for Scientific and Industrial Research. This committee has recently issued its sixth technical paper, which deals with the natural lighting of picture galleries. Besides containing useful information on such matters as the distribution of illumination and avoidance of troublesome reflections in the glass of picture frames, the report discusses the important question of the effect of sunlight in causing fading of colours.

Street Lighting.—Keen interest is being taken in the subject of street lighting, following the issue of the B.E.S.A. standard specification for street lighting. It will be recalled that this specification was discussed in draft before our own Society and others earlier in this year, and there is no doubt that these discussions have proved useful in suggesting modifications of wording where the original clauses were not entirely clear.

The fourth annual conference and exhibition arranged by the Institution of Public Lighting Engineers in Brighton during September 12th–15th afforded another useful opportunity of reviewing progress in this subject. The proceedings have been fully reported in the journal.* The Presidential Address of Mr. Alex. C. Cramb drew attention to the relatively small progress in street lighting as compared with other fields of illumination. Mr. Cramb also emphasized the drawbacks of the present arrangement whereby each local authority provides the lighting of its own district, with the result that considerable variations in illumination occur on any road passing through differently controlled areas. He accordingly advocated the establishment of some form of central authority, a suggestion that has been made before our Society on several occasions, and was put forward by the writer in a paper before the London Society as far back as 1914. The B.E.S.A. standard specification for street lighting was introduced in a paper by Messrs. L. B. W. Jolley, J. M. Waldram and R. Watson, and led to an interesting discussion in which a number of members of the Illuminating Engineering Society took part. The general feeling was expressed by Mr. Cramb, who urged that the specification should now be adopted as the best that could be evolved at the present moment, and utilized in practice as fully as possible; only through actual experience of its working can it be properly tested and information on desirable modifications acquired. It was, however, suggested in the course of the discussion that it would help considerably towards rendering the specification widely understood if model installations representing requirements for the various classes could be carried out and demonstrations of methods of testing arranged. This suggestion is now being considered with a view to obtaining the co-operation of the Ministry of Transport in this scheme.

Interesting papers were also presented by Mr. John Christie on the public lighting of Brighton and by Mr. R. L. Matthews on "Road Traffic and Public Lighting as Seen by a Chief Constable." The exhibition on this occasion was also exceptionally complete, 24 firms participating, and both gas and electric lighting were represented. An interesting feature was the display of a number of forms of luminous aids to traffic and danger signs, etc., and the use of artificial light in this way seems destined to increase and to furnish a new field for illuminating engineering.

Street lighting again received attention at the Public Works, Roads and Transport Congress and Exhibition, held at the Royal Agricultural Hall during November 14th–19th. Two papers on this subject were presented respectively by Dr. J. W. T. Walsh and Mr. W. J. Jones. (The former received the distinction of an award of the second prize—£25 and silver medal—in the open competition organized by the Papers Committee of the Congress.) Dr. Walsh's paper contained an analytical survey of the various factors underlying good street lighting, and Mr. Jones dealt with the street lighting of London, concluding with the suggestion that a public lighting department should be formed for the whole of London, with a view to bringing about a uniform policy in the lighting of streets and undertaking investigations by which all street-lighting authorities would benefit. Mention may also be made of an informative paper by Lt.-Col. J. A. A. Pickard (General Secretary of the National "Safety-First" Association), entitled "A Review of Road Accidents," in which the importance of a complete research into the chief causes of accidents (including inadequate lighting) is emphasized.

Other Recent Events.—Amongst other important congresses and events may be mentioned the initiation of the C.E.D.A.C. Circle campaign, under the auspices of the British Electrical Development Association, and the sixteenth annual meeting of the British Commercial Gas Association at Southampton during October 3rd–5th. Reference to these events will doubtless be made in the reports on progress in gas and electric lighting to be presented at the opening meeting. I need not do more than express the hope that the propaganda of both industries will continue to conform with the principles of good lighting which our Society is advocating, so that all efforts to educate the consumer in the importance of better lighting will be made on a concordant and uniform plan.

The programme for the session includes a visit to the E.L.M.A. Lighting Service Bureau in February next, when an opportunity will be afforded of hearing all about its most recent activities. Meantime reference may be made to the useful educational work which the Bureau and the corresponding organizations in leading provincial centres are doing. It is reported that applications for the special illumination design course have this year been on an unprecedented scale.

Development of the B.E.S.A. and National Illumination Committee.—Before proceeding to the important meeting of the International Illumination Commission at Bellagio attention may be drawn to one important development at home—the extension of the National Illumination Committee through the co-operation established with the B.E.S.A., which has now inaugurated a special illumination section with a view to standardization in illuminating engineering. Reference was made in the annual report of the Council to the useful specifications already issued dealing with portable photometers, industrial lighting reflectors, etc., and the most recent addition is the B.E.S.A. standard specification for street lighting, which will, it is hoped, have an important influence on public lighting in this country.

It is a matter for congratulation that illuminating engineering has now reached a stage when standardiza-

* *The Illuminating Engineer*, October, 1927, pp. 273–278.

tion is possible, and it is very desirable that the National Illumination Committee should be fully representative of all bodies in this country interested in illumination. This procedure should not affect the independent position of these various bodies in dealing with their specific fields of work. The work of the B.E.S.A. committees is primarily of a technical nature, and there have already been several occasions when the usefulness of independent platforms, on which all aspects of illumination are represented, has been demonstrated. It is, for example, a great advantage when technical specifications can be presented for discussion and possible amendment, and such discussions are of great value in making specifications more widely known and better understood.

The Illuminating Engineering Society, owing to its impartial and representative constitution, occupies a unique position in this respect, and its journal should prove of increasing value as a clearing-house for information from all sources.

Meetings and Congresses Abroad.—The past summer has been marked by an exceptionally large number of congresses dealing with illumination. First and foremost amongst these was the meeting of representatives of the various technical committees of the International Commission on Illumination held in Bellagio (Italy) during August 31st to September 3rd.

A special account of the proceedings at this gathering has been recently published in the journal.* The aims and objects of the Commission have also been summarized in a very useful official report, which contains a brief history of the Commission and an account of its origin. At the recent gathering all the countries affiliated with the Commission were represented, and 67 delegates of various nations were present. Many important problems, especially those associated with industrial lighting and the framing of regulations to avoid glare from motor-car headlights, were discussed. The general question of the scope and functions of the Commission has also been receiving attention. One was glad to find amongst delegates a general feeling that future work should be conceived on broad lines, dealing with illumination and the application of light as a whole, rather than the utilization of some particular illuminant.

It was also gratifying to note the presence of representatives of the ex-enemy nations, thus showing the removal of all bars to full international action. One result of this gathering should be a considerable addition to the numbers of the corresponding members of the Illuminating Engineering Society, who will be of considerable service in furnishing information on developments abroad and promoting the interchange of views on which future international agreement is necessarily based.

Another noteworthy event was the twenty-first annual convention of the Illuminating Engineering Society (U.S.A.), held during October 11th–14th. A list of the chief papers and reports has already been published in the journal, and in coming issues it is hoped to include abstracts of some of the most important papers. Attention may be drawn to one method, which has also been followed by the Illuminating Engineering Societies in Germany—the grouping of a series of papers dealing with different aspects of the same subject. Thus on successive days such questions as colour-values of illuminants and daylight illumination, industrial lighting and the use of light in aviation were dealt with on these lines.

This tendency was even more strikingly illustrated at the sixth annual meeting of the Illuminating Engineering Society of Karlsruhe, which was devoted to a discussion on physiological, psychological and æsthetic aspects of illumination. Papers were read by leading architects, physiologists and psychologists, as well as lighting experts. This happy method of bringing together various experts, so that their joint experience may be applied to the development of illuminating engineering, is due in no small measure to the efforts of the President of the Society, Prof. Dr. J. Teichmüller, whose ideas on "Light Architecture" (the use of artificial light to aid the designs of the architect) have attracted such attention.

The annual meeting of the German Illuminating Engineering Society, held in Hamburg during September 30th to October 1st, was likewise devoted to the exchange of views between experts on special subjects. The papers on the opening day were all devoted to the relation between illumination and health and efficiency. Medical men and lighting experts dealt with the subject from the physiological and technical standpoints, and such matters as the relation between illumination and efficiency, injuries to health caused by bad lighting, and the protection of the eyes against ultra-violet rays were discussed. The meeting being held in Hamburg, a shipping city, the second subject for discussion, the use of light in connection with navigation, was an appropriate one. Papers were read on such subjects as the lighting of docks and harbours, the visibility of navigation lights, and the design of lighthouses and beacons, and the discussion was followed by a tour round the port.

Such discussions show how the fundamental idea underlying our own Society—the co-operation between producer and user and the joint efforts of lighting engineers with outside experts, such as architects, medical men, inspectors of factories, etc.—is also accepted by the illuminating engineering societies in other countries.

Joint discussions with other bodies on subjects of common interest have always been a leading feature of our own proceedings, and the future development of illuminating engineering depends very largely on the development of this idea.

The next item on the programme was the Report of the Committee on Progress in Electric Lighting, which, in the absence of Mr. S. H. CALLOW (Chairman of the Committee), was read by Mr. J. S. DOW, and was as follows:—

Progress in Electric Lighting (1926-1927)

(Report of the Committee on Progress in Electric Lamps and Lighting Appliances [Mr. S. H. Callow (Chairman), Mr. C. W. Sully, Mr. J. W. Elliott (Secretary), and Mr. J. Y. Fletcher]).

Progress in the application of electric illumination was considerably hampered during the period under review by the general strike in the summer of 1926 and the extended dispute in the coal industry, which was not settled until the latter part of the year.

The regulations which were imposed by the Government on the use of electric light, combined with the general disorganization of industry, considerably retarded the natural development of electric lighting, and even prevented the normal maintenance of existing electric-lighting installations. Consequently, the natural progress which would have been recorded in this report for the winter of 1926-27 is necessarily restricted, but it speaks volumes for the enterprise of the electrical industry in enabling us to record the following activities which have been carried on, in spite of the difficulties previously referred to.

Electric Lamps.—There have been no outstanding developments in the design and manufacture of electric lamps, although there has been a decided development in the demand for, and the application of, the types which were referred to in the report of last year. The use of the inside-frosted lamp has made steady progress, and is now being employed in the standard sizes up to 100 watts in all classes of lighting service.

As previously recorded, this new lamp, which is sometimes called the "Pearl" or "Purlite" type, only absorbs from 1½ per cent. to 2 per cent. of the light emitted by the filament, and the fact that this high efficiency is combined with a considerable reduction in glare has met with the ready approval of electricity consumers. Lamp manufacturers have been congratulated on their foresight in providing this better lighting medium at the same price as the clear lamps, which they are so rapidly displacing.

The sale of lamps with white opal or white sprayed bulbs has also been maintained, many consumers pre-

* *The Illuminating Engineer*, November, 1927, pp. 305-310.

ferring the complete obscuration of the filament in spite of the slightly higher absorption, which is characteristic of this type of lamp.

White opal lamps, particularly in the larger sizes, have been employed with considerable success for the illumination of streets and other open spaces, in order to obviate the disadvantages of glare.

The returns of lamp manufacturers indicate a steady change over from vacuum lamps to the more efficient gasfilled lamps, and this process has been considerably accelerated in recent months, due to the reduction in price of gasfilled lamps, which became effective on September 1st, 1927. In view of the fact that there is now little difference in price between gasfilled lamps and other types it is anticipated that gasfilled lamps will quickly supersede all other types for general lighting purposes.

The policy of introducing new ratings, which was inaugurated when the inside-frosted lamps were introduced, has been well supported by the public, and the demand for 15- and 25-watt lamps has rapidly increased in recent months. So encouraging, in fact, has been the response that lamp manufacturers are considering the advisability of discontinuing the old ratings of 20 and 30 watts in the near future.

Lamp manufacturers, during the last year, have given considerable thought to the problem of the reduction in the number of types of lamps which they manufacture, and are constantly striving to arrive at a satisfactory solution which will enable them to concentrate on a simplified range of sizes which, whilst giving the highest possible lighting service to the public, will enable manufacturing costs to be reduced to a minimum. This programme, however, is considerably complicated by the large variety of supply voltages which exist throughout the country, but it is hoped that, as a result of the many discussions which have taken place in consequence of the problems connected with the Electricity Bill, standardization of voltage will be accelerated.

Lamp manufacturers look with envy on the conditions which exist in other large countries where the simplification of types and the standardization of voltage has facilitated the problems of mass production and consequent reduction in manufacturing costs.

In spite of the many difficulties of the past year, it is encouraging to find that there has been a demand for increased light by the British public. As an example, a comparison of the average wattage of lamps sold in England and other European countries indicated in the following table is of interest:—

Average wattage of lamps sold in European countries.

Great Britain	61.20
Germany	47.55
Hungary	47.14
Switzerland	44.97
Norway	40.55
Austria	40.30
Italy	39.06
Sweden	35.97

The high figure for Great Britain is no doubt due to the fact that the percentage of domestic consumers is low compared with other countries, and it is possible that the average will fall if the rate of domestic connections takes a sharp upward rise. The continued effect of the more-light movement on commercial and industrial interiors, however, will act as a counterbalance, so that in the long run the comparatively high figure for Great Britain should be maintained, if not exceeded.

Home-Lighting Campaign.—The great national effort which was made during the winter of 1926-27 jointly by the Electrical Development Association and the Electric Lamp Manufacturers' Association to improve and encourage the development of electric lighting in domestic service concluded in March of the present year.

Complete details of the results achieved have been widely circulated, and it is, therefore, not proposed in this report to record the results in detail.

There is no doubt that the study which was made by the public of the recommendations for good home-lighting practice given in the competition book, of which one and a half million were circulated, has resulted in a considerable improvement in home lighting.

An analysis of the votes cast by the competitors in the competition clearly indicates that the home-lighting lessons contained in the book were carefully studied before the entry forms were filled in. In most of the rooms which were illustrated in the book by far the largest number of votes were given for the lighting units which illuminating engineers would recommend as being the best lighting practice.

It is worthy of record that the lighting arrangements in the majority of the 83 demonstration electric homes which were organized were of a much higher standard than similar exhibitions which have from time to time been organized in past years, thus indicating that the electrical industry has also profited by the engineering data which was made available to them through the medium of the campaign organizers and electrical manufacturers.

Shop Lighting.—Although progress in the important field of shop lighting was completely suspended during the coal dispute last season, there has been a very encouraging revival during the autumn of the present year. Whereas a few years ago exposed pendant lamps for the illumination of show windows were in the majority, they are now the exception rather than the rule in windows of the main shopping thoroughfares in London and provincial towns. It is evident that shopkeepers are now alive to the commercial value of good window illumination. This fact is particularly apparent in an important thoroughfare such as Oxford Street, London, where, in addition to the large stores, it is now the practice for the smaller shops to employ high-intensity window illumination provided by top reflectors. The use of spotlights and floodlights for focussing high-intensity beams of light on particular objects in the display is also being widely adopted, particularly in shops selling ladies' gowns, millinery, etc.

The rapid increase in the intensity of illumination in shop windows amongst competing shopkeepers is causing some embarrassment to illuminating engineers, who are finding it difficult to establish standards of illumination with any degree of permanency; for whereas the progressive shopkeeper now fully realizes that light has a very considerable advertising value in addition to its utilitarian advantages, the more backward tradesmen still need educating with regard to this aspect. Whilst the subject was limited principally to the consideration of visual acuity, the engineering problem was not unduly complicated, but there has not been sufficient research and commercial investigation carried out to enable illuminating engineers to establish illumination intensities based on the economic and advertising advantages of light as a sales force.

Details were recorded in *The Illuminating Engineer* of May, 1925, of a survey which was conducted on the lighting of 830 retail shops. The majority of these same establishments were resurveyed during the period under review, and a comparison clearly indicates the upward trend of electric-lighting practice in this sphere. Space does not permit a complete analysis to be given, but the following data will give a general indication of the progress made in two years:—

	Per cent. of total.
Original shops with improved window lighting	20.5
Increase in number of lamps per window ...	66
Increase in total wattage per window	84
Increase in average wattage of lamps	11

In addition to shop windows, there is also a marked improvement in the methods of illumination employed for the interiors of business premises. Totally enclosed diffusing units have been installed in large numbers during the last year, and the intensity of lighting has steadily increased. One interesting and important aspect of the upward trend of shop lighting, which has not previously received the consideration which it deserves, is the very marked improvement which it has effected on the load factor of central stations.

In important shopping districts, particularly in the West End of London, it is now quite general for the

retailer to employ artificial lighting throughout the day. There is no doubt that one reason for this practice is the discovery by shopkeepers that daylight reflections from plate-glass windows can be considerably mitigated by the use of high-intensity window lighting. An observer very recently summed up the situation by stating that light in retail shops was now being employed by the horse-power instead of by the candle-power, as was the case a few years ago.

Factory Lighting.—The publication of the B.E.S.A. standard specification for industrial reflectors, which was recorded in the progress report of last year, has been well received both by manufacturers and consumers, and has resulted in a simplification of factory-lighting practice.

Industrial lighting progress was particularly hampered by the disputes previously mentioned, but owing to the improvement in trade during the last few months there has been a welcome reawakening of interest on the part of industrial executives with regard to the all-important question of Illumination. The E.L.M.A. Lighting Service Bureau report that they have recently conducted an investigation on the lighting of the engineering industries in the Midlands, and a paper dealing with this subject is shortly to be presented at a meeting of the Illuminating Engineering Society.

Generally speaking, the observers found that in the larger factories moderately good lighting systems are employed, but in the smaller workshops there is still a great need for intensive education. It appears that there has been an all-round increase in the intensity of illumination on the work, principally due to the use of gasfilled electric lamps in place of the less efficient types, but in many cases this increased lighting has been accompanied by a corresponding increase in glare and other illumination malpractices.

The investigators, as a result of their numerous discussions with industrial leaders, are confident that an intensive campaign throughout the country for the improvement of factory lighting would result in considerable benefit to the electrical industry, industrial organizations, and employees.

A report on factory-lighting practice would be incomplete without reference to the work of the Department of Scientific and Industrial Research Board, which is fully recorded in the joint report issued by the Industrial Fatigue Research Board and the Illumination Research Committee. The typesetting investigation, in particular, is worthy of study by all illuminating engineers and factory executives, and very clearly indicates the economic value of high-intensity lighting in industry. This report is, of course, of great value, since the authority of the investigators is beyond question, and no possible commercial bias influences their conclusions.

Office Lighting.—As a contrast to the progress recorded under the previous two headings, lighting practice in offices has not shown any great advancement. It is still the common practice in many business houses to employ drop-pendant systems of lighting with all its disadvantages. On the other hand there is a decided tendency for the more enterprising establishments to provide greater lighting comfort for their employees by the adoption of totally enclosed fittings and higher standards of illumination. A few outstanding examples of high-intensity lighting in drawing offices have been recorded in the period under review, in one of which an intensity of 33 foot-candles was provided by an almost shadowless system of modern lighting units.

Electricity Showrooms.—There is a notable increase in the design of new electrical showrooms to include arrangements which enable good lighting practice to be demonstrated. Electrical traders are realizing the difficulties which the old system of equipping the showroom as a warehouse presented both to the intending purchaser and the showroom assistant. Suites of rooms for demonstrating lighting effects and electrical appliances are becoming usual, and the intelligent demonstration of good lighting principles is frequently incorporated.

An ideal showroom layout was discussed in a paper by Mr. H. E. Walker, which he presented at the Convention of the Electrical Contractors' Association at Scarborough, and it was agreed that the proposed layout was a good solution of the showroom-lighting problem.

Decorative Lighting.—Some decorative lighting innovations have been introduced in some of the newer hotels, theatres and cinemas during the past year. The influence of the lighting effects which were introduced at the Exhibition of Decorative Arts in Paris is being felt in this country, particularly in theatres and hotels. Many novel lighting effects were also introduced at the Advertising Exhibition at Olympia, and it was apparent that the organizers and the architect responsible had given very careful thought to the design of the lighting arrangements when the general scheme and the individual exhibits were being planned.

A Spectacle of Light.—The spectacle was organized jointly by the Institution of Electrical Engineers and the Electric Lamp Manufacturers' Association, and was produced by Major W. R. Creighton. The principal events in the history of artificial lighting from the prehistoric days to the present time were portrayed. A voluntary staff of 120 performers, in costumes of various periods, took part in the production, which was staged on the grand staircase of the Natural History Museum. The lighting effects were a principal feature of the display, and many electrical properties were specially designed for the production.

Outdoor Lighting.—Probably the most spectacular item to record under this heading is the lighting arrangements of the greyhound racing tracks which have been established in various parts of the country. The whole success of this new enterprise depends on the efficiency of the lighting system, and the engineers who have been responsible for their design are to be congratulated on the rapidity with which they so satisfactorily fulfilled the exacting requirements.

Many new floodlight installations, both of a commercial and industrial character, have been installed. An outstanding example in the latter category was the illumination by means of floodlights of the constructional work in connection with the new grand stand on the Epsom racecourse. The lighting arrangements enabled continuous building operations to be carried on for 24 hours per day.

Considerable progress has been made in the design and application of equipment for the lighting of commercial aircraft routes, and although this development is largely carried on under the direction of the Air Ministry, the work is of interest to electrical manufacturers as indicating the types of equipment which may be called for in the future.

Street Lighting.—The principal event in the sphere of street lighting was the issue of B.E.S.A. Specification No. 307, which deals exhaustively with the subject. The adoption of this specification by public lighting authorities should do much to improve the general standards of illumination throughout the country. The subject was discussed at the Convention of the Institution of Public Lighting Engineers at Brighton, and the specification was well received by the experts present.

In connection with this Convention an exhibition of street-lighting apparatus was organized, and a full range of modern appliances was displayed by leading manufacturers of street-lighting equipment. It was noticeable that pole-top units and lanterns, employing reflector and refractor components, were much in evidence. In general, it cannot be stated that any great advance in street lighting has occurred during the period under review, although there are some notable exceptions.

It is evident from the discussions at engineering societies and the technical treatises which have been published during the past year that there is no lack of technical data available on this important subject. The lack of progress appears to be entirely due to the difficulty in obtaining the necessary financial allocations which are necessary to bring street-lighting installations into line with modern recommended practice. In order to remedy existing conditions, it will be necessary to bring considerable influence to bear on the lighting committees who are responsible, in order to impress them with the importance and urgency of taking action.

Lighting Development Activities.—The Lighting Service Bureau of the Electric Lamp Manufacturers' Association have continued their intensive programme in the cause of better lighting. In addition to their work in connection with the home-lighting campaign previously mentioned, a large number of lectures to technical and commercial institutions have been given. The demonstration rooms in London have been completely reorganized, and many new devices for demonstrating the advantages of good lighting have been installed.

The Provincial Lighting Service Bureaux in Newcastle, Glasgow and Manchester, which are operated and financed by joint committees representing all sections of the industry, have also been actively engaged on a similar programme in their respective districts.

The illumination design courses which are held simultaneously in London and in the provinces are continuing, and the sixteenth course is in progress at the present moment.

Increased Interest in Illumination.—There has been a very marked increase during the past year in the interest displayed in many quarters in the subject of illumination. This is particularly notable in the technical press, where articles dealing with the subject have frequently appeared. Many contributions on the subject of lighting have been written by scientists and others not directly concerned with the electrical industry. There has been an increased number of papers dealing with illuminants and illumination presented before learned institutions, which indicates that more attention is being given to artificial lighting problems. This development is becoming world-wide, and lighting activities are now in operation in all principal countries.

With a revival of trade in Great Britain, and a reasonable period of industrial peace, there is every reason for optimism in the advance of better lighting practice being adopted in all spheres.

The CHAIRMAN then called upon Mr. H. TALBOT to present a Report on Progress in the Gas Lighting Industry, which was as follows:—

A Report on Progress in the Gas Lighting Industry (1926-1927)

By H. TALBOT

(*Chairman of the Lighting Section of the Society of British Gas Industries*).

1. *Preliminary.*—The object of this brief report is to indicate generally the progress that has been made in various sections of the gas lighting industry from the beginning of the lighting season in 1926 to the corresponding period in 1927. The first-mentioned date corresponds approximately to the closing stages of the disastrous coal strike, which affected every British industry and, to some extent, the development of the gas lighting industry. It is opportune at this point to remark that no public utility service emerged from the difficult period of the coal strike of 1926 with a finer record of achievement than that of the gas industry generally, even though the restrictions which were imposed on the consumption of fuel of all kinds, whilst they might not have affected very seriously the use of gas for domestic lighting, certainly did interfere with the normal march of progress in the application of gas to public lighting. The total consumption of gas, however, during 1926 was, according to the Board of Trade returns, considerably higher than during 1925.

The gas industry is far and away, with the possible exception of the railways, the largest public utility service, and the big majority of artificial lighting in this country is at the present time done by gas.

Owing to the brief time available for the compilation of this report no sort of pretence has been made to completeness, and only general ideas of progress along the principal directions enumerated below can be indicated. The different branches of gas lighting which will be considered are:—

(*a*) Domestic Lighting.
(*b*) Public Lighting.
(*c*) Shop Lighting.
(*d*) Factory Lighting.
(*e*) Miscellaneous.

2. *Domestic Lighting.*—Under this heading will be considered a number of improvements in burner design which, whilst primarily applicable to the use of gas for domestic lighting, find similar spheres of usefulness in other branches of the industry, with appropriate modifications depending upon the special conditions to be served. For example, there has been during the year under review development of a number of burners of the same general type either showing distinct improvement in performance on pre-existing types or a different and more satisfactory construction or both. An example of the former is afforded by the introduction of a specially designed burner for a single incandescent mantle which, by careful relative proportioning of the gas orifice, the Venturi tube, the superheater chamber and the screen in this chamber or in the mantle nozzle, effects an almost complete aeration of the incoming gas prior to combustion at the burner nozzle, producing a higher flame temperature with a more compact flame than has so far been achieved, together with a complete silence in operation. These single burners, with "diffuser" chamber and disc, are very generally made in refractory material, which, whilst being more fragile than metal, has the advantage of a less maintenance and upkeep cost with a slightly higher efficiency in performance, i.e., candles per therm of gas consumed.

The second development above referred to is illustrated by the introduction of a refractory superheater fitting with two or more nozzles depending from the superheater chamber without any screen, gauze or perforated refractory disc to impede the flow of the combustible gas mixture. It is claimed that the special internal construction of the superheater eliminates all tendency to "light back," as well as doing away with the "popping," which is so destructive to the incandescent mantle.

As regards the construction of the metal parts of burners for domestic use, development has continued along two main directions. The first is in the employment of less easily corrodible "finishes," or, alternatively, the use of aluminium wherever the soft nature of this metal is not an objection.

With the growing use of superheater burners carrying two or more small-size mantles for domestic lighting there has been a marked increase in the application of diffusing glassware, notably in the form of bowls of various types, to the home-lighting problem. Indeed, many domestic gas lighting appliances at the present time consist of the merest essentials of the bunsen burner with the mantle nozzle or nozzles and with gas and air-regulating devices, the whole being provided with means of supporting a bowl fitting, a silk shade, or in some cases a combination of the two. These bowls are usually in ordinary glassware, plain or decorated, and one type of lighting unit recently brought out employs an opal or decorated glass shade, with or without silk flounce, as well as the bowl fitting.

The spread of multi-nozzle superheater lighting units to the field of domestic use has led to the introduction of means for "diffusing" the uprising current of hot gas emanating from the unit, with resulting benefit to the downrods, chains, etc., of the fitting and the ceiling of the room where the unit is fixed. Such "diffuser discs" may take various forms, but are usually of glass placed over, and relatively near to, the burner, and may be regarded as a modern development of the old glass "bell" used with the first upright mantle burners.

In addition to the increase in the use of superheating units carrying small mantles, mentioned above, there have been introduced during the past year a number of attractive designs of small "economy" lighting fitments for use where only moderate illumination is required, as well as new varieties of brackets, flambeaux, etc., of "period" or other artistic character. Here again non-corrodible metals like aluminium or fairly permanent "finishes" on the fittings seem to be preferred.

Further reference may be made here to the increasing use of the smaller mantle for domestic lighting as against the larger "universal" size which still has the greatest vogue. Two Bijou size mantles used on a superheater fitting will give approximately the same light as a universal mantle and consume under ordinary conditions

25 per cent. to 40 per cent. less gas, thus showing a definite economy. With an increase in the number of mantles the gas economy for a given illumination, or the light from a definite gas consumption, is greater, the figures being usually stated by expressing the results in so many candles per cubic foot of gas used. It is to be regretted that, with the now universally employed "therm" system of charging for gaseous energy, a more scientific mode of expression, e.g., B.Th.U.'s per candle-power hour, mean hemispherical rating, could not be employed as was suggested by the chairman of the Society of British Gas Industries in an address about a year ago.

It is appropriate at this juncture to refer to steps that have been taken during the past year towards diminishing the bewildering variety of fittings for domestic gas lighting. The B.E.S.A. Sectional Sub-committee, dealing with the neck dimensions of translucent glassware, is to be congratulated on completing its work, which it is hoped will be much extended in the future. There are, for example, almost 100 different varieties of "gas adjusters" used in domestic burners, and the dimensions of these, as also of many "small" gas fittings, could be defined with advantage and with very considerable reduction in the useful variety of articles involved.

3. *Public Lighting.*—According to official figures, apart from the calendar year, 1926, as already mentioned above, increase in the use of gas for public lighting, notably street lighting, is to be recorded from 1920 to 1925. During the present year, the firms specializing in this work report a very busy time in preparation for the 1927-28 lighting season, and it is expected that the figures for 1927 will again show an increase in the consumption of gas for this purpose. This is very satisfactory when it is remembered that in many towns where the electricity works are the property of the Corporation the department responsible for the control of the works is very often entrusted with the control of the street and public lighting, and it is natural for such department to use electricity wherever possible for this lighting purpose.

Whilst dealing with public lighting I may suggest that the standard specification for street lighting recently issued by the B.E.S.A. scarcely takes sufficient account of one vital point—the necessity for screening high-power lamps when used for street and public illumination; otherwise the specification is a most admirable document, and has led during the past year to a most interesting and friendly collaboration between gas lighting and electric lighting authorities during its discussion. Such conferences, of which the meeting of the Association of Public Lighting Engineers at Brighton a few months ago is a further example, cannot but be beneficial to both parties, and it is gratifying to note the remarkable progress the Association referred to has achieved during the relatively short time of its existence.

It is appropriate here to support the suggestion recently put forward for more co-operation between the different authorities responsible for the lighting of London and the Greater London area, or, better still, for one unified control to take charge of this very important matter. In these days of rapid development in motor traffic it is imperative that reasonable and reasonably uniform illumination of streets and highways along which any respectable number of vehicles passes should be provided, and this can best be done in one or other of the ways suggested above.

One of the most notable developments to be recorded in the domain of street lighting is the rapid extension of the use of superheater lamps and superheater street-lighting sets carrying smaller mantles than those of ordinary or universal type. This tendency was remarked upon in the preceding section, and is nowhere more pronounced than in connection with street lighting, where the superheater system was first introduced. The introduction of the superheater is simple where new lighting is being installed, but very many more of the old-fashioned "square" street lanterns are now being "converted" to the superheater type. The economy of the change from the point of view of gas consumption has already been referred to, and another point is worthy of notice and that is, the increased life of the smaller mantle as compared with the durability of those of a larger size. This arises in part from improvement in methods of manufacture, but also because, other things being equal, a smaller mantle would be expected to be more lasting than one of a larger make. Consequently, maintenance figures which at one time were of the order of six to eight mantles per burner per annum have been reduced within a very short time to one-third or less of this figure, principally by the change first mentioned.

Another point of interest well exemplified by changes which have taken place during the past year is the astonishing progress in the use of automatic controllers for lighting and extinguishing street lamps. These are mainly of the clockwork variety, although the "pressure-wave" type is also widely used. The controllers can be adjusted so as to turn out a proportion of the lights in a multiple-light lamp at midnight or at any other time when diminished illumination is permissible, and the saving in labour more than pays for the cost of installation.

Many notable street-lighting installations have been erected during the past year, amongst which may be cited some hundreds of superheater lamps of modern design at Penarth, Margate and Portsmouth, the latter being equipped with automatic control. Specially interesting installations have been erected in Burnley and in Nottingham, where superheater lamps have been carried by cast-iron brackets fixed on the existing columns supporting the power wires for the electric tramways. The cost of the gas installation is very much diminished by utilizing the column of the tramway service for supporting the gas pipe and the gas lamp instead of erecting a special gas column, which has been the usual practice. It is confidently anticipated that an extension of this principle will be noted during future years.

Whilst progress in the directions indicated above is to be recorded, one cannot help regretting that there are still on the streets so many of the old "square" type of street-lantern body, which has little to recommend it except its presence where it is wanted. There is abundant room for replacement of these antiquated devices by more scientifically designed and up-to-date lanterns of more pleasing and artistic appearance, and although such lanterns are for the most part being installed where new work is in progress, much more remains to be done by way of replacement. Moreover, the arrangement of the lamps in the streets and highways in very many cases leaves much to be desired, especially in old installations. The "diversity factor" is often too high, and where superheater installations have replaced the older upright burners, "glare" very frequently results. These points deserve the earnest attention of gas engineers, for the public and street-lighting load is by no means a negligible quantity; large and extending as is the market for the use of gas in other directions.

It is useful here to refer to many new devices using incandescent gas lighting which have been introduced for traffic direction. Many of these were exhibited at the Brighton meeting, and some have been described in recent issues of the journal of the Illuminating Engineering Society. A great deal of ingenuity has been expended in devising apparatus of this kind, and no doubt many more appliances of this nature will be developed in the near future.

4. *Shop Lighting.*—The increasing application of superheater units to interior and exterior shop lighting and the extension of use of diffusing glassware bowls to such purposes are the outstanding features of the past year. In addition, a number of interesting and ingenious designs of shop-lighting fittings have been introduced by various makers, notably one with a kind of double-cased reflector affording complete protection to the ceiling from the uprising current of hot gas and air when the burners are alight. In the sphere of gas-lighting as applied to shop premises, the same tendency is to be noted during the past year as has been shown with electric lighting for some time, viz., the demand for an increased standard of illumination above what was regarded as satisfactory only a few years ago.

A number of most ingeniously designed and interesting ceiling fittings using diffusing glass bowls have been

introduced during the past year, generally, though not essentially, in conjunction with a ventilating shaft. The appearance of the fitting, especially if equipped with the form of switch-operated distant control introduced a short time ago by one of the principal firms in the gas lighting industry, is almost exactly similar to that of an electric fitting and the light is of a most pleasing quality. The ability to arrange for the ventilating of shops, public halls and similar buildings at the same time as the lighting installation is fitted is one of the great advantages possessed by gas lighting.

Although the present tendency in shop lighting by gas is to use bigger units than formerly, there is an increasing application of the small and handsome aluminium superheater lamp with Vitreosil globe which fits in with almost any scheme of decoration and shop equipment.

The use of gas lamps for outside shop lighting has developed more perhaps in the direction of pressure units than in that of superheater lamps, although these are extensively employed.

5. *Factory Lighting.*—In the sphere of factory lighting some tendency to adopt superheater multi-burner fittings instead of the old single-burner type has to be recorded, and, in conjunction with such equipment, various ingenious forms of reflector have been designed. One type worthy of special mention uses a white-enamelled steel reflector so as to give a diffused top light in the factory at the same time as concentrated downward lighting for any particular job or process. The use of indirect lighting bowls and fittings is extending, and here also the general standard of illumination is increasing.

A particularly interesting recent installation of gas lighting in a works canteen has just been completed for one of the principal London gas companies. The centre lighting of a hall about 60 feet by 150 feet long has been effected by a number of superheater units with specially designed large silk shade screens, whilst 2-arm superheater type wall brackets of especially artistic description complete a very pleasing assembly.

It must be admitted that very much still remains to be done before factory lighting using gas is as effective as can very easily be attained, and gas engineers in general, or, perhaps better, one or other of the main organizations in the gas industry could with advantage turn its attention to this branch of the gas lighting industry for research, development and increased business.

6. *Miscellaneous.*—Under this heading a number of minor developments in gas lighting will be dealt with:—

(*a*) Gas mantles: Improvement in the quality of the gas mantles now being manufactured by the principal British houses engaged in this industry has already been noted, and the tendency in that industry to standardize products and eliminate all goods of relatively inferior type and construction is much to be commended. With the introduction of the safeguarding duty about two years ago importations of mantles from abroad have notably diminished, and the quality of British-made mantles at the present time is higher than it has ever stood during the whole 40 years that mantles have been manufactured.

(*b*) "Radiation" treatment: A most interesting investigation, which is at present being conducted under the ægis of one of the gas organizations, has reference to the therapeutic effect of radiation of different types produced by media rendered incandescent by gas. The corresponding effect of radiation from certain varieties of electric lamp has already been fairly well investigated, and much work in this direction is at present going on. It is interesting to report that similar results have been obtained from gas-using appliances, and further experiments are proceeding.

(*c*) "Daylight" gas mantles: The modern incandescent gas mantle gives light the composition of which approximates to that of daylight from a white sky, and by suitable adjustment of the composition of the mantle much closer coincidence between the two than is ordinarily achieved can be secured. One of the principal London gas companies has done much research in this matter, resulting in the production of standard "daylight" mantles of specified "quality," which, whilst not intrinsically so luminous as the ordinary mantle—the deficiency being from 10 to 20 per cent.—enable relative colour values by this artificial light to be better estimated. Some of these mantles are finding application in the Yorkshire textile area, and a most interesting installation in a London art gallery was recently completed. There is doubtless a good field for the further employment of mantles of this type in various directions.

(*d*) Distance control without by-pass: Many efforts have been made in the past to light gas burners from distant points without employing a constantly burning by-pass flame, but so far without permanent success. Catalytic methods have principally been used, and it is interesting to report that, after a great deal of experimenting and after several months' trial of the device in question, provisional patent protection has just been taken out for a catalytic system operating somewhat differently from, and apparently with better prospects of permanent success than, those hitherto utilized. It is too early yet to express any opinion on the scheme, which employs some of the most recent scientific discoveries in the applications of catalysis to chemical change, but if reasonable success is achieved a very great step forward will have been made.

(*e*) Education: The scheme introduced during the year by one of the principal London gas companies for the education of its apprentices and employees is a noteworthy step in the development of more friendly relations between employers and employed, in which, by the way, the gas industry has always taken the lead. Most of the larger provincial gas companies, and many of the smaller ones, have similar schemes in operation, although perhaps on a less ambitious scale than the one just mentioned. Moreover, the importance of the training of salesmen for gas company showrooms and the education of all employees who come in contact with the customer in the idea of "service" is fully recognized, and steps are constantly being taken to improve the efficiency of the gas undertakings in this respect. The movement has the active support and co-operation of the principal gas organizations and is in part responsible for the increase recorded from year to year in the consumption of gas. It is suggested, as has already been mentioned, that the principles of good lighting deserve even more attention in this way than they are now getting from most gas companies, although there is some indication that a few gas companies are beginning to realize this fact.

(*f*) Propaganda: The activities of the British Commercial Gas Association in the direction of collective advertising for the gas industry and in assisting with local efforts of this kind have been most marked in the year under review, although it is to be regretted that less has been made of the gas lighting side of the industry than its importance warrants. At the same time much more could usefully be done than has so far been effected in all branches of the industry, and the principal gas engineers and those in authority controlling the industry are fully alive to the necessity for intensive and extending propaganda to secure a bigger share of the lighting and heating market.

(*g*) Co-operation: A pleasing tendency noted of late years has been the readiness of gas engineers and electrical engineers to co-operate in matters in which they are mutually interested, or in which they could usefully help one another. Instances of such co-operation have been given in the foregoing, and the movement deserves every encouragement. It may be that ultimately electricity will bulk more largely in the national economy than does gas, but that day, if it is coming, is very far distant, and in the meantime the gas engineer has nothing to lose and the electrical enginer has much to gain by association of effort instead of blind and unreasoning mutual antagonism. This point was referred to, notably by the Secretary of the Illuminating Engineering Society, at the recent gas conference in Southampton, and was sympathetically received.

7. *Conclusion.*—In conclusion, most grateful thanks are due, and are respectfully offered, to all those gentlemen and firms who have been good enough at very short notice to offer help in the compilation of this report.

These reports were listened to with close attention, after which those present adjourned for light refreshments.

Exhibits of Recent Lighting Appliances*

On resumption, the CHAIRMAN explained that, in accordance with the usual practice at opening meetings, a representative collection of exhibits of interesting lighting appliances had been assembled.

The first item was the exhibit of a very simple and compact attachment for illuminating existing road danger-signs, which was shown by Mr. PATMORE (General Electric Co. Ltd.). This utilized a lamp screened by a parabolic reflector to illuminate the "cross-roads" device and a lamp with half-obscured bulb to reveal the red triangle at the top. A feature was the effective illumination produced with complete absence of glare.

Mr. AUSTIN (Siemens and General Electric Railway Signal Co.) gave an interesting demonstration of the new coloured electric signals now being adopted on the railways, in substitution for the existing semaphore method of signalling.

Mr. L. C. JOHNSTONE (Mur-Ray Signs Ltd.) next showed the effect of a series of these lens signs in the beam of a lantern, emphasizing the great importance of careful optical design, and pointing out the economy of this form of sign for publicity purposes, and its convenience for many purposes in connection with traffic.

Mr. L. G. APPLEBEE (Strand Electric and Engineering Co. Ltd.) gave a brief description of the stage lighting recently introduced at the Albert Hall, which has several interesting and novel features, and also illustrated a new form of "dead front" switchboard now being widely adopted by leading theatres.

Mr. HARRIS (Philips Lamps Ltd.) exhibited two interesting novelties, the Philips "Duo-Savelite" and "Duo-Photo" lamps. The former contains two filaments, consuming respectively 4 and 25 watts, but both contained within a round opal bulb. The latter likewise uses two filaments, one of which is shielded by a ruby-glass bulb. Thus, by operating the switch, the operator can get either white general illumination or a red light suitable for photographic work.

Mr. SIMON showed several examples of the "Typerlite," which is an adjustable standard for use with typewriters, and billing, adding and similar office machines. A feature is the extreme ease with which the apparatus can be set up or dismantled, and as it only requires a 15-watt lamp it is very economical in action.

The remaining exhibits (with the exception of the final one) all related to reflectors, glassware, and similar lighting accessories. Mr. G. HERBERT (Benjamin Electric Ltd.) exhibited the new "one-piece" R.L.M. reflector, which has an angle of cut-off of 20°, and fully complies with the standard specification for industrial reflectors. The great advantage of the reflector being made of a single piece of metal, thus obviating all the weaknesses inherent in joins, was strongly emphasized.

Several types of pleasing lighting units employing "three-ply" glassware were shown by Mr. FRANCES (Wholesale Fittings Co. Ltd.), and Mr. H. H. LONG (Metro-Vick Supplies Ltd.) demonstrated some new types of show-window units and lanterns. Mr. STOCKWELL (Falk, Stadelmann & Co. Ltd.) exhibited and described the ingenious "Holdrite" suspension device, by which all screws, etc., are avoided, and any unit can be dismantled for cleaning with great ease.

The final item on the programme was the demonstration of the Ultra-Violet Testing Cabinet by Mr. L. H. MILLAR (Kelvin, Bottomley & Baird Ltd.). The cabinet was mounted in an adjacent dark room, to which the audience proceeded at the end of the meeting. The cabinet utilizes a mercury-vapour lamp screened by special glass, so that only the invisible ultra-violet rays are transmitted. Many objects placed within the cabinet showed strong fluorescence under the rays, and some beautiful examples were shown. The colour and degree of fluorescence of an object may be of great aid in detecting traces of impurities or contamination inappreciable by ordinary light, and in distinguishing between genuine and spurious articles. In addition, the cabinet furnishes a new method of analysis for the chemist and physicist. Some striking instances of its uses in this connection were quoted, but its full possibilities are only now being discovered.

At the conclusion of the proceedings a very cordial vote of thanks to authors and exhibitor, and to the E.L.M.A. Lighting Service Bureau for its hospitality was moved by the CHAIRMAN, and was carried with acclamation.

* A full illustrated account of this display, based on information being collected by exhibitors, will appear in our next issue.

Street Lighting Regarded as an Illumination Problem*

By J. W. T. WALSH, M.A., D.Sc., A.M.I.E.E., F.Inst.P.
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THE adequate and suitable lighting of streets is one of the most difficult problems of to-day. The ever-increasing volume of traffic makes continuous improvement imperative, but the rapid development of lighting units, whilst favourable to efficiency, is liable to be confusing. In what follows the subject will be regarded entirely from the point of view of the illuminating engineer. The chief requirements of a street-lighting system are: (1) The discernment of large objects on the roadway; (2) the discernment of irregularities on the road surface, its edges, and any permanent obstructions; (3) a good general appearance when in operation. Requirements (1) and (2) should be met without the aid of driving lights on vehicles, which inevitably cause glare. In towns street lighting should be of such a standard that no vehicle lights (other than recognition lights) are needed.

In attempting to meet these requirements it has been suggested that with ideal street lighting the horizontal illumination should be practically uniform, but this consideration is modified by the effect of direct reflection from shiny surfaces. Objects, indeed, are often seen as "silhouettes" against such a shiny background. It has also sometimes been contended that the illumination of vertical surfaces (e.g., the sides of vehicles, etc.) should receive more attention.

Various criteria of street-lighting excellence have been proposed or adopted. The most familiar of these is the specification of the minimum illumination on a horizontal surface at a height of one metre above the roadway or at road level. The chief drawback of this method is that it takes no cognizance of the average illumination. For this reason a combination of minimum horizontal illumination with a maximum variation ratio (maximum to minimum illumination) seems preferable. But decision on the maximum permissible range is not easy. Reduction of the variation ratio involves increasing the candle-power of lamps in directions just below the horizontal, and this is apt to have a dazzling effect.

Furthermore, one vital factor—the effect of the glaring of street lamps on visibility—deserves consideration. In what follows the author aims at showing how this effect may be evaluated and so far as possible diminished.

Under normal conditions objects are seen by reason of their contrast with the background. Ability to perceive a given contrast depends on the brightness of the objects viewed, but it is diminished by glare from street lamps. A small object, slightly darker than its background, can just be distinguished when its brightness is G per cent. less than that of the background, where G has a value of 1.7 under ordinary daylight conditions or with good artificial lighting indoors.

* Abstract of a paper read at the Public Works, Roads and Transport Congress.

Bordoni and Holladay have shown that the effect of a glaring source depends solely on the illumination produced at the observer's eye, and not independently on its brightness, size or distance from the eye, but this conclusion is only valid when the angle subtended by the source of the eye is relatively small—according to Bordoni within 3°. It should also be noted that the above conclusion only applies to the effect of glare on the capacity of the eye to observe contrasts; it may well prove that the sense of discomfort experienced when viewing a very bright source follows altogether different laws.

The author next discussed in detail the best method of determining the contrast which a given object will present with its background for a specified system of street lighting. This involves a number of assumptions which may not always be fulfilled in practice—especially owing to the fact that the surface of the roadway is usually more or less shiny, and behaves very differently when the road is wet. It is, however, possible to get a fair idea of normal conditions based on tests conducted on a typical asphalt surface. Effects of glare and brightness are likewise considered by the aid of numerous tables and diagrams, showing how the factor G may be calculated under assumed conditions. Thus in one particular instance it is shown that G may be expected to have a value of about 4.5, as compared with 2.5—the percentage contrast which could just be distinguished if all glare were removed. In this case, therefore, glare had the effect of diminishing ability to perceive contrast to half.

The above analysis leads to a discussion of the importance of shading and the possibility of applying a 3° cut-off in order to screen sources completely from the eyes of distant observers. The blocking-out of these rays does not constitute any real drawback so far as illumination of the roadway is concerned, whilst from the standpoint of reducing glare it has distinct advantages. In the original paper the application of this method to typical lighting units, equipped with incandescent mantles and electric lamps, is considered, and it is shown that this procedure should be feasible in practice. The diminution of glare is undoubtedly one of the most important considerations in future systems of street lighting. On the other hand it is, for various reasons, and especially in view of the shiny nature of road surfaces, unnecessary to strive after too uniform an illumination of the road surface; a variation of 40 is usually satisfactory, and will lead to a much smaller variation in brightness than theoretical calculations of distribution of illumination would suggest.

The Street Lighting of London*

By W. J. JONES, M.Sc., A.M.I.E.E.

(*Engineer to the Electric Lamp Manufacturers' Association of Great Britain.*)

THE problem of street lighting in London becomes daily more important, owing to the rapid changes which are taking place in the habits of the people. Streets are becoming more congested, the speed and volume of traffic has greatly increased, and some residential thoroughfares are fast becoming centres of business and main traffic arteries.

It is now over 12 years since a paper on this subject was read before the Illuminating Engineering Society. Since that time many improvements in the design of equipment have been presented. Street-lighting appropriations are, however, inadequate to meet present-day requirements. Throughout England the average values are only 5.3d. in the £. In many instances the amount expended on public libraries, baths, etc., greatly exceeds that applied to street lighting; the cost of scavenging and watering roads is often 50 per cent. greater than that of lighting. Yet there is probably no other public service which could be met so readily and appreciated by the public for so little cost.

* Abstract of a paper read before the Public Works, Roads and Transport Congress.

The chief requirements may be summarized as follows: (1) Visibility of objects on the road; (2) visibility of objects on the footpath; (3) low brilliancy of light sources within the angle of vision and avoidance of glare; (4) even illumination (usually horizontal is considered); (5) minimum obstruction of traffic or pedestrians; (6) reliability and constancy of power of lighting sources; (7) cost; (8) plenty of light, almost independent of minimum visibility requirements.

An object may be rendered visible either by virtue of its own brightness or by appearing dark against a lighter background. The latter "silhouette" effect plays a considerable part in street lighting, and is illustrated in the original paper by views of St. Martin's Lane. The presence of light buildings at the sides of a street is beneficial both in reflecting a certain amount of light and in serving as a background against which dark objects may be seen.

In the next section of the paper the author presents typical diagrams showing the usual distribution of light in streets, and alludes to the experiments of Bordoni on glare. He draws the conclusions that (1) the road or other surfaces in the line of vision should be sufficiently well lighted; (2) the light source should be mounted as high as possible, with a view to avoiding glare; (3) the candle-power in the direction of the observer should be such that glare is reduced to a minimum. Whilst intrinsic brilliancy of the light source is not a factor in relation to distant visibility, in many installations lamps are mounted on short standards. In such cases obscured lamps or diffusing lanterns should be used. A table is presented showing the very moderate brilliancy (from 4 to 24 candle-power per square inch) of white sprayed lamps of 30 to 500 watts.

The author emphasizes the need for classification of streets in relation to their illumination requirements, and a number of typical thoroughfares in London are discussed. It is suggested that classification should be undertaken by a joint committee, on which such bodies as the Ministry of Transport, the London County Council, Surveyors and Municipal Authorities, City and Metropolitan Police, Royal Automobile Club, and Chambers of Commerce might be represented. A feature in the United States has been the co-operation of shopkeepers in schemes for providing better lighting, it being recognized that bright illumination is a great aid to business. In this country an example of such methods is to be found in Sheffield, and a very striking instance in America is the lighting of State Street, Chicago. Within a length of a street of 3,150 feet there are 140 2,000-watt lamps, each yielding 45,000 lumens. A pair of standards with two of these lamps is erected every 100 feet. The cost of the installation was 100,000 dollars. The expenditure was met by a voluntary taxation of 12.54 dollars per foot frontage for the first five years and 7.76 for the next five years. In this installation approximately four times the light available in Oxford Street or the Strand is provided.

Some hints on spacing, and on the lighting of squares, bends and turnings are next given, one useful suggestion being that wherever possible a light-painted screen, behind a lamp facing the incoming road, should be placed at right-angle bends.

The second section of the paper is devoted to historical notes. The anomaly of the present position, whereby the lighting of London is controlled by 32 different boroughs, each independently making their own arrangements, is pointed out. It is suggested that a Public Lighting Department for the whole of London should be established. This organization would be controlled by a street-lighting board representative of the existing lighting authorities.

The formation of such a department would (1) make possible a uniform policy in the lighting of streets, (2) provide means for effecting investigations and improvements, and (3) investigations of the design of lighting fittings, testing of electric and gas lamps, regular inspections of street lighting, etc. The organization itself might be constituted on similar lines to that already existing in Glasgow, and should include a qualified staff of engineers and facilities for testing lighting fittings and accessories of all kinds.

Some Notes on the 1927 Report of the Committee on Street Lighting of the Illuminating Engineering Society (U.S.A.)

By F. C. CALDWELL (Professor of Electrical Engineering at the Ohio State University)

THE Committee on Street Lighting of the Illuminating Engineering Society (U.S.A.) has been a notable organization. With a membership of over twenty, it is so widely representative of those in America who are interested in street lighting that when its members have agreed among themselves there is little likelihood of much opposition from others. This very fact, however, has made such agreement especially difficult. Hence the present report, the first extensive one that the Committee has submitted, represents the efforts of two and a half years to develop a satisfactory degree of unanimity among the members. Again and again, what seemed at first hopelessly divergent views on the often doubtful theories about street lighting have been successfully brought together on a mutually agreeable statement. It has been a real privilege to take part in these discussions. Since its organization the Committee has held nine meetings in eight cities, seeking and studying some particularly interesting installation of street lighting in each. Thirteen members, on the average, have attended these meetings, and have travelled an average distance of 468 miles to reach them. The cordial co-operation of several other organizations is also gratefully acknowledged.

The report as submitted is divided into three parts—Part I, the transactions of the Committee; Part II, the principles of street lighting; and Part III, a comparison of European and American conditions and practices in street lighting. This report is so extensive that it will be practicable in this brief presentation to only touch upon the high spots.

A discussion of the relation of street lighting and automobile headlighting came up at several meetings. While the members of this Committee did agree that bright headlights are unnecessary on well-lighted streets, a recommendation for doing away with such bright headlights under such conditions failed to receive the endorsement of other interested groups, and this matter was thus left in abeyance.

A proposition which obtained the unanimous approval of the Committee, with little discussion, is contained in the following resolution: "That there are no conditions of street lighting prevailing in the United States which justify the use of smaller than 1,000-lumen lamps, and that the 2,500-lumen lamp is the smallest size which may be used with good economy."

The Committee was early impressed with the great divergence in judgment which existed among its members as to the relative merits of different street-lighting installations. Considerable time over a period of two years was, therefore, spent in an effort to develop a system of appraisal, which, by analysing the problem into its component simpler elements, should make possible greater agreement among qualified judges. It was first agreed that desirable characteristics of street lighting could be grouped in two classes, "appearance" and "value of lighting." It was also decided that no fixed relative weighting could be assigned as between these two groups of characteristics. The system of characteristics, with the weightings finally, and after much discussion, agreed upon, is presented in the following table:—

APPRAISAL OF EFFECTIVENESS OF STREET ILLUMINATION.

	Maximum Points Allotted	
	Residence Side Street	Traffic Thoroughfare
Appearance	Weight	Weight
Daylight appearance of single unit in its environment	30	20
Daylight appearance of street as affected by the street-lighting system	30	30
Night appearance of single unit in its environment	20	20
Negative—Glare		
Night appearance of street as affected by the lighting system and by the lighting effect produced	20	30
Negative—Glare		

VALUE OF LIGHTING AT NIGHT.

A. *To Motorist.*		
1. Average pavement brightness	23	25
2. Distribution of brightness	11	14
3. Vertical illumination	11	17
Negative—Glare		
B. *To Pedestrian between Curbs, including all Cross Walks.*		
1. Conspicuity	11	11
2. Visibility	8	8
Negative—Glare		
C. *To Pedestrian on Sidewalk.*		
1. Horizontal illumination	6	4
2. Vertical illumination	8	5
3. Distribution of illumination	9	6
Negative—Glare		
Shadows		
D. *To Occupants of Property.*		
1. Protection afforded	9	7
2. Visibility	4	3
Negative—Glare		
Total		

"The best concept which can be formed of an 'ideal lighting system' for the street under consideration earns the maximum allotment of points listed in the table for a street of its class. The 'ideal' depending upon circumstances may be the best attainment of the art at this time, or it may be a higher conception thus far unrealized in practice.

"Decision is then reached as to degree of excellence to which an installation attains in each particular listed in the table. This is expressed as a proportion of the maximum allotted points.

"From the sub-totals of points assigned for each principal aspect of lighting effectiveness deduction is made of such number of points as is considered to represent the extent to which the effectiveness is diminished by such glare as is present.

"It is considered that a street-lighting system which may be regarded as reasonably excellent under modern conditions should attain to 75 per cent. of the total points for each of the four major divisions (A, B, C and D) of the utilitarian aspects of street lighting. It is the Committee's view that any street-lighting system which does not attain to 50 per cent. in each of these important particulars is seriously deficient and in need of alteration to bring it into accord with modern requirements."

It will be more difficult to obtain agreement in appraisal of "appearance" than in the more technical aspects of street lighting. By analysis of the problem into simpler elements, and the use of numerical expressions, better consensus of opinion should be obtainable than would otherwise be possible. Of course, in appraising the value of the lighting, actual measurement rather than judgment should be employed wherever practicable. Illumination values are easily calculated from the distribution curves of the lighting units.

"If it be assumed for purposes of discussion that any or all of these measurements are accurate and complete, it still remains true that if their indications as to street-lighting effectiveness are borne out by the observation and judgment of competent specialists they will be accepted, whereas if they differ from such observation and judgment they will not be accepted.

"In the further development of this method of appraisal the Committee is therefore confronted with two large problems:

1. The development of acceptable methods of measuring street-surface brightness and glare.

2. The reconciliation of all measurements of the qualities of street lighting with competent judgment thereof.

By analysing the problem into its component parts and seeking to arrive at means of gauging effectiveness in each particular, the Committee hopes to develop methods of measurement and to cultivate the judgment of its members, so that ultimately a satisfactory method may be developed."

An important contribution to the solution of the appraisal problem was the report contributed by Mr. A. J. Sweet, a member of the Committee, and printed in the Transactions for 1926 (pages 982 to 1031).

Two important pieces of research have been begun under the auspices of the Committee. The first to be started was on the deleterious effects of glare, as found in street lighting. The Committee was early impressed with the inadequacy of the information available on this subject. Mr. Ward Harrison offered, on behalf of the National Lamp Works of the General Electric Co., to undertake an extensive study of this subject on their lighting demonstration street near Nela Park, in Cleveland. A sub-comittee was organized to direct this work. Various methods were considered, and some preliminary testing undertaken. A method which would give data on the effectiveness of the lighting for automobile drivers appeared to be most needed, and it was decided to determine the frequency with which the drivers who passed over the street would avoid a fairly inconspicuous obstruction placed so as to lie in the most used path for the traffic moving in one direction. After experiments with various objects to be used as obstructions, a laminated rubber bar with a steel base was selected. This bar was 30 inches (76 centimetres) long, 1½ inches (4 centimetres) high, and 4 inches (6½ centimetres) wide. This obstruction was formidable enough in appearance to induce careful drivers to turn out for it, if observed; but produced such a slight jolt that it would attract little attention if it was not observed in time, and was therefore run over. An observer stationed in an automobile recorded the "hits" and "misses." With proper correction for the careless and inattentive drivers, and those who would accidentally miss the obstruction, a measure of the effectiveness of the illumination could be determined. Some work has been done with the following variables—various mounting heights, lamps bare versus in 14-inch (36-centimetre) opal globes, and lights respectively shielded and exposed to view. While results that promise well for the method have been obtained, the only report on them that the Committee is prepared to make at present is that "experience thus far has convinced the sub-committee that automobile-headlight glare on the test street is so much more seriously detrimental to vision than is glare from street lamps that it may prove difficult to measure the effects of street-lamp glare in the presence of motor traffic." Later the Committee hopes that work may be done with the visibility-testing equipment described by P. S. Millar and S. McK. Gray in *The Electrical World* of April 9th, 1927.

Recently some important measurements of street brightness have been undertaken through the kindness of the Chairman of the Committee, Mr. P. S. Millar, and the Electrical Testing Laboratories. The results of these tests have not yet been announced.

Part II: Principles of Street Lighting.—At the first meeting of the Committee, in March, 1925, it was proposed that a statement of the generally accepted principles of street lighting be drawn up. The divergence of opinion among the members, however, was so great that the project was postponed, and has only been carried through during the present year. The statement of principles now proposed is regarded as tentative, and criticism and suggestions are invited. As this document is to be subject to growth and development, a syllabus capable of expansion was constructed as follows:—

100.—**Street Conditions:** 110—Classification, design and dimensions. 120—Street surface. 130—Buildings: 131—Proximity to street; 132—Class. 140—Trees. 150—Traffic: 151—Vehicular; 152—Pedestrian.

200.—**Visibility:** 210—Lamp locations: 211—Mounting height; 212—Spacing; 213—Transverse location.

220.—**Characteristics of Luminaires:** 221—Lamp rating; 222—Candle-power distribution; 223—Lumen output; 224—Brightness; 225—Colour of light; 226—Steadiness of light..

230.—**Characteristics of Illumination:** 231—Intensities upon various planes; 232—Uniformity; 233—Direction of incident light; 234—Pavement brightness; 235—Building-front brightness; 236—Shadows. 240—Glare.

300.—**Appearance:** 310—Of lighting equipment: 311—By day; 312—By night. 320—Of street as affected by lighting equipment: 321—By day; 322—By night.

400.—**Economics:** 410—Installation. 420—Operation.

This statement as it now stands covers about seven pages. The following are a few of the more interesting items. The most obvious and least controversial propositions of the statement are in general not included among these:—

100—So far as is compatible with other requirements, conditions of the streets and surroundings should be made promotive of good visibility.

110—For lighting purposes streets may be classified conveniently according to their type and traffic function. A satisfactory classification follows:—

Primary business streets; secondary business streets.

Heavy traffic thoroughfares; medium traffic thoroughfares; light traffic thoroughfares.

Alleys; highways.

120—The street surface should be of as favourable light-reflecting quality as practicable. [See 213 (1).] From the illumination standpoint light-coloured pavements are preferable. When not light-coloured a specular (shiny) surface is preferable to a dull (mat) surface. The curb should contrast with the pavement or with the abutting parkway or sidewalk.

121 (1)—A rough listing of pavements with respect to their light-reflecting qualities will place concrete at the head of the list and oil-bound macadam at the bottom of the list. Other generally used materials range between these two.

130—For business streets, building fronts having good light-reflecting qualities improve visibility and appearance at night.

140—So far as is compatible with other requirements, obstruction of light by trees should be minimized.

141 (1)—Trees should be near the property line rather than between the sidewalk and the curb.

141 (2)—Trees should be trimmed to a reasonable extent to favour the lighting.

141 (3)—Varieties of trees which tend to be free from low-growing branches are preferable.

141 (3)—Responsibility for all street trees should be lodged with a designated competent authority.

201—The effectiveness of street illumination is measured by ability to see rather than by illumination intensity or silhouette, or any other single factor.

202—Visibility requirements of all users of the street should be met, including those of vehicle drivers and passengers, pedestrians and occupants of property abutting on the street.

211—Lamp-mounting height should be selected with reference to weighted requirements for good visibility, good appearance and economy of installation and operation.

211 (1)—Generally speaking, and within practicable limits, effectiveness is improved by increasing mounting heights beyond present practice. (See 240.)

211 (2)—With present types of lighting equipment 15 feet is the minimum mounting height for effective illumination. Only in case of extremely heavy forestation should any exception to this rule be considered.

211 (3)—Where spacings are 250 feet or more, the mounting height should not be less than 20 feet.

211 (4)—6,000- to 15,000-lumen lamps in pendant equipment on thoroughfares should be mounted at least 20 feet high.

213—Transverse location of lamps with reference to the curb line should be determined by the weighted

requirements of good visibility, good appearance, and economy of installation and operation.

213 (1)—In proportion as the street surface is specular, placement of lamps well out over the roadway tends to enhance effectiveness, provided they are not unduly glaring.

213 (4)—If practicable, lamps on curves should be placed on the outside of the curve. On curved roadways lamps should indicate roadway direction. A staggered system on such streets is generally undesirable.

222—It is good practice to direct a relatively large percentage of the light toward the street.

222 (1)—Redirecting equipment should generally be employed in residence streets and thoroughfares.

230—Street illumination should promote visibility and good appearance of the street.

231 (2)—For thoroughfares, average horizontal illumination* of at least 0.2 foot-candle, attainable with available illuminants in good practice, at an expenditure of about 40 lumens per linear foot is to be considered a minimum. For streets exceeding 80 feet in width more light is required; under dense traffic conditions much higher illumination is desirable.

231 (3)—For residence streets average horizontal illumination of at least 0.05 foot-candle should be provided, with higher values recommended. In good practice this minimum can be obtained with an expenditure of about 10 lumens per linear foot.

232—While uniformity of illumination intensity is desirable, departure therefrom within reasonable limits, particularly in the direction of higher intensity, is not objectionable. Dark spaces between lamps should be avoided.

240—Glare, as experienced in the street, on the sidewalk and from neighbouring buildings, interferes with vision, is annoying or even offensive. It also introduces hazard and detracts from the appearance of lighting equipment and of the street. Glare should be minimized. Other things being equal, the effects of glare are diminished:—

(*a*) As the candle-power and brightness in the direction of the observer are reduced.

(*b*) As the lamps are removed from the centre of the field of view. This is accomplished most effectively by increasing the mounting height.

(*c*) As contrasts are reduced, as by illuminating surroundings (building fronts, etc.).

It is possible to confine glare within unobjectionable limits. The use of diffusing globes has no measurable effect on that part of glare which has been called "blinding effect," or decreased ability to see when at attention. However, such equipment is effective in reducing ocular discomfort and in promoting good appearance. The effectiveness of street lighting is greatly diminished by glaring headlights. Headlight beams which conform with the specifications of the Illuminating Engineering Society are less objectionable. "Depressed beams" are even less objectionable.

300—The appearance of street-lighting equipment should reflect good taste and sense of propriety. While congruity with the character of the street, its environs and use is desirable, equipment should deviate in the direction of better taste than is displayed in a low-grade or unæsthetic street. Simplicity, dignity and grace rarely displease, and are never out of place as a visible expression of a civic service.

Part III.—"It occurred to the Committee that advantage might be taken of extensive interchange of visits between European and American engineers to formulate and record prevailing opinions on street lighting in the several countries. Accordingly expressions of opinion were sought from Americans who have visited European countries recently. These being secured, statements upon which several individuals agreed were compiled and circulated among the whole number for criticism. The resultant combined statement reduced to a few brief propositions proved to be acceptable as an expression of American opinion.

In the interests of mutual understanding and advancement of the art, this American statement was distributed in the spring of 1927 to 76 technicians in Europe who were believed to be acquainted with lighting conditions in America. These were invited to comment upon the statement with a view to improving its accuracy and representative character.

At this writing replies have been received from 37 of these."

For the most part, the comments of the European critics indicated a considerable degree of agreement with the views of the American engineers. The following gives some of these opinions, together with summaries of the European criticisms.

"Buildings are likely to front immediately upon the sidewalk and to have shuttered windows. Show-window lighting in business streets has not been developed as in America. In the secondary streets shops are likely to be shuttered, and there are few lighted show windows."

Correspondents from England, France, Germany and Switzerland were unanimous in their comment that the development of store-window lighting in Europe is making very rapid progress, especially in the large cities.

"There is relatively little sign lighting. Neon tubes for signs are used relatively more largely than in America.

Streets tend to be narrow and winding. On many of the streets there are few trees.

In some European countries there are few, if any, houses along country roads, the tendency being to cluster in villages."

From England and France come the claims that sign lighting is rapidly increasing. England states that street trees are being extensively planted, and Switzerland questions the superiority of America in this particular.

"There is less night traffic. Headlighting for night automobile driving in Europe is poorly controlled. There is, in general, a larger proportion of horse-drawn vehicles than in America."

France claims notable improvement in headlighting, also the use of 50- or 65-watt lamps, and states that at present all new cars are equipped with depressible beam devices.

Germany states that automobile headlighting laws have been in force during four years, and are working well. England and Germany both hold that in their countries the ratio of automobiles to population will soon equal that in America.

"The tungsten gasfilled lamp is not used as generally in Europe as in America, although its use is being extended. High-pressure gas mantle lamps are still employed to a considerable extent for the main avenues and places. Flame arc lamps are employed to a slight extent, having been superseded in many cases by tungsten-filament lamps."

There is general agreement among European correspondents that arc lamps are rapidly giving place to

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*The term "lumens per linear foot" and like expressions are measures of light output for street lighting. Such a term is analogous to "watts per square foot" employed in interior lighting. It does not take into account the proportion of light which reaches the street, and is but a rough and incomplete index of the grade of illumination.

The term "average horizontal foot-candles," because it does indicate the light delivered upon the street, is a somewhat more complete index of the grade of illumination, but is not a complete measure since it does not take into account several important factors, notably glare, brightness, and distribution of light.

When lumens or watts per linear foot are shown without specification a street of not more than 80 feet between property lines is contemplated.

incandescent lamps in street lighting. Except in Italy, the frequent use of gas is admitted.

The evidence with regard to the relative intensity of illumination in Europe and America seems to indicate little difference on the average in the lighting of the highest class of streets and places, but there is general agreement that for secondary streets in large towns, and especially in small towns, American lighting is much ahead of most European lighting. In England rapid improvement is observed.

" In Europe lamps are mounted over the middle of the street more generally than in America."

It appears from comments that this practice is not at all general in Paris, though not uncommon in other parts of France. On the other hand, in Germany such mid-span suspension is coming more and more into use.

" There is a greater tendency to deliver light on the street surfaces, restricting light thrown upon buildings and above the horizontal.

Lamps sometimes are supported on suspension wires or brackets fastened on building fronts.

The ' shepherd's crook ' type of lamp post is used quite extensively. There is rather less crudity of posts than in America."

The only disagreeing comment is from Germany, where it is claimed that, while downward concentration of light is normal on minor streets, the illumination of the building fronts is increasingly prevalent in important streets and those where monumental buildings are to be seen.

Under the heading " Street-Lighting Specifications," American and some European conditions are contrasted. In America, in spite of several efforts in the past to construct model street-lighting specifications, nothing that is generally accepted has been produced. The equipment and service to be supplied usually forms the basis of American contracts.

On the other hand, in Germany and England extended specifications are at least in tentative use. Brief reviews of these are given. Some outstanding points observed are the following: In both countries the intensity on a horizontal plane is to be specified. In Germany average and minimum values are to be used. Recommended values are given for three grades of streets, density of traffic being the basis of classification. In England only the mid-span value is to be specified.*

The German specifications also consider, in a general way, shadows, lack of uniformity and glare.

The English specifications include also minimum mounting heights, 13 feet and over for different classes, and maximum ratio of spacing to height, 12. Directions for a quantitative glare determination are also given.

In conclusion, the Committee emphasizes the need for extensive research work on the problems of street lighting, and expresses the opinion that in general much higher illumination than is now in use can be justified for street lighting in American communities.

Glare in Street Lighting

In commenting on the recent discussion of the standard specification for street lighting at Brighton, *Municipal Engineering* remarks that the specification was assumed to deal with " only one aspect of glare—the deleterious effect on ocular sensitivity." Our contemporary enquires " Why ' only ' ? " The treatment of glare assumes that it is dependent merely on candle-power and not on intrinsic brilliancy, so far as usual conditions in street lighting are concerned. But even if this is correct, it is suggested this assumption may not apply to other effects of glare. Our contemporary concludes: " We may be supersensitive to glare, but for our part we prefer to have lights of high intrinsic brilliancy well screened, whatever the angle they subtend at our eyes, and however well they fit the diagrams in the specification."

* Compare the illumination specifications proposed above under the classification 231 (2) and 231 (3).

The Importance of Shadows in Industrial Lighting

MUCH has been heard of the increases in production secured by using higher illuminations. It is sometimes overlooked that other factors—such as avoidance of glare and troublesome contrasts—are at least equally important. A very instructive account of some experiments illustrating this point was recently contributed by Mr. Arthur A. Brainerd to *The Electrical World*. These experiments related to a textile mill, where shadow conditions are notoriously troublesome. The work of the operators on certain looms consisted in *first* tying the ends of the warp already in the loom to a new spool; *second*, winding and threading the bobbins; *third*, detecting broken ends, stopping the looms, threading the broken ends through the reeds and bobbins and tying in the breaks as quickly as possible. Obviously it is of vital importance that the period for stoppages to repair defects should be as short as possible. Actually such looms were running for from 58 to 70 per cent. of the time. During this period the process is automatic, and lighting conditions would presumably have little influence on results. Better lighting would be beneficial in diminishing defects and shortening the time required for remedying them.

The original system of lighting consisted of 75-watt bare lamps on drop cords, spaced about 8 feet apart and 8 feet above the floor. Owing to shadows, the actual working illumination was not more than 5 foot-candles. The first step was to improve the illumination. This was effected by replacing the existing sources by 300-watt lamps in " glass-steel " diffusers, thus raising the average intensity to 21 foot-candles and the usable intensity in shadow to 2.75 foot-candles. But a study of production data showed that this change had led to an actual *decrease* in production of 3 per cent. This was undoubtedly due to the high contrast and glare.

The next step was to soften the shadows, and four R.L.M. domes equipped with 100-watt bowl-enamelled lamps were substituted. This gave 14 foot-candles. Deep shadows caused by projecting parts of looms were almost eliminated, but heavy shadows were still cast by parts of the observer's body. Nevertheless an average increase in production of 3.85 per cent. was recorded.

The conditions under this arrangement, though better, were still far from satisfactory. A third arrangement involving the use of 200-watt totally indirect units was therefore tried. This system, while giving an average intensity of only 7.9 foot-candles, gave an actual *usable* illumination very much greater than that obtained from the original system. Glare and harsh shadows were practically eliminated, and tests revealed an increase in production of 7.7 per cent.

Tests were then run with the same system, but with illuminations of 12, 20, 30 and 40 foot-candles. An analysis of records showed that the production was increased 11 per cent., but above that value there seemed to be no justification for the use of higher intensities from the standpoint of increased production.

Increased production, however, was not the only benefit derived from better lighting. This particular group of machines were known as " dark looms," and weavers would sometimes leave rather than work in this section. After the change all weavers welcomed the opportunity of working in this area, and, in addition, there were fewer headaches and much less spoilage of material—the latter an additional economic advantage not included in the records of production.

This research was conducted during a period of nearly two years, jointly by the Philadelphia Electric Co. and the National Research Council. In the words of the author: " A study of the results shows that under-production and discontent among employees were due almost entirely to harsh shadows and not to low-illumination intensities. In fact, intensity of illumination may be a meaningless expression unless care is taken to ensure a quality of illumination consistent with the character of the work performed, the value of the product and the wages of the operator."

POPULAR & TRADE SECTION

COMPRISING

Installation Topics—Hygiene and Safety—Data for Contractors—Hints to Consumers

(The matter in this section does not form part of the official Transactions of the Illuminating Engineering Society; and is based on outside contributions.)

Electrical Advertising

THE earliest recorded electric signs were those "Edison" signs made by W. J. Hammer in 1882 and 1883, the first being installed in the Crystal Palace and a smaller one with a flasher installed in Berlin. The early designers of signs had a number of difficulties to overcome, and the rate of progress has been different in various countries. In England, for instance, in the early days, there were a number of restrictions because it was thought that flashing signs would alarm horse traffic, and even now almost each Borough Council has its own special lighting restrictions. Let us consider the chief factors in the development of electric signs:—

Construction.

(*a*) The effects of halation must be considered when designing all forms of flashing signs.

(*b*) Visibility of individual letter signs is bad at certain angles, and the sign has a poor daytime appearance compared with that at night. It is necessary to consider both daylight and night appearance.

(*c*) Quite an early difficulty in the evolution of signs was that of obtaining suitable lampholders capable of withstanding climatic conditions. Phosphor-bronze springs are used in B.C. holders, and nowadays it is more common to use porcelain Edison screw holders.

Lamps.

(*a*) Carbon lamps are sluggish in action.

(*b*) Metal lamps are speedy in lighting up.

Lamps are sometimes required with special formation of filament to give a satisfactory distribution of light, and, generally speaking, the best results are obtained when the filament itself is obscured. Durability is more important even than efficiency.

Coloured Lamps.

Colour may be introduced into signs by one of the following methods:—

(*a*) Lacquered bulbs.
(*b*) Natural coloured glass bulbs.
(*c*) Hoods for lamps.
(*d*) Coloured glass caps.
(*e*) Daylight bulbs.
(*f*) Colour-sprayed lamps.

Of these, the last are being more and more extensively used since the wattage of lamps used for sign purposes is so rapidly increasing.

Switchgear.—It is well known that immediately movement is introduced into an electric sign it becomes mores attractive, and the following three types of movement are employed:—

(*a*) Conventional movement such as flashing.
(*b*) Reproduction of real movement.
(*c*) Motion for stunt effect only.

The mechanical motor-driven flasher is the most usual form of device employed for introducing movement, and it can be designed to give the following effects:—

(*a*) Simple flashing signs.
(*b*) Scintillation.
(*c*) Colour change.
(*d*) Spelling effects.
(*e*) Pouring wine, revolving wheels, rockets, flames, locomotives, flags, dancing, juggling, performing animals.

(*f*) Moving borders, twinkling effects, geometric designs.

Still Signs.—There is, however, a great demand for "still" signs, such as:—

That shown in Fig. 4 on the preceding page.

Neon signs.

Dayanite signs, shown in Figs. 1 and 2 on the preceding page.

Restrictions.—It was previously mentioned that there are all kinds of local regulations regarding the installation of signs, and there are often prolonged delays in obtaining the necessary permission to install signs. The amount of overhang on the pavement is often mentioned in such regulations.

Characteristics of Electric Sign.—There are several factors which make a successful sign:—

(*a*) Attractive power or ability to compel attention.

(*b*) Legibility, clear definition of words and design.

(*c*) Selling power.

(*d*) Ability to impress message and make it endure.

Electric sign advertising has certainly exclusive characteristics:—

(*a*) Brightness (eyes turn to brightest object in view).

(*b*) Potent factor in arresting attention.

(*c*) Animation, mystery, fascination, psychological effect, originality, novelty, distinctiveness, individuality.

Colour.—Colour adds charm and richness to a sign and makes a definite appeal to the senses. In the design of a sign there should be characteristic borders, and as much aid as possible given to enable recognition of the letters or subjects by lifting it completely from the surroundings.

Position.—A sign should be installed on sites that are free from conflicting influences, and will obviously appear better in comparatively dark surroundings.

Maintenance.—One often finds signs imperfect, and this has a bad psychological effect upon the attracting power of the sign.

Possibility of Business.—There is an enormous business to be done in electric signs which will improve sales of lamps and materials, and also prove of tremendous value to the central stations. It should be borne in mind that there are in use approximately 250,000 lamps in London, and that the average renewal is twice per annum. Furthermore, it is surprising to realize that one comparatively small lamp will consume 20 units of electrical energy per year.

Poster Illumination.—Comparatively recently the lighting of posters has become more and more general, and when one realizes that there are 20,000 16-sheet posters in Great Britain, and that each would require at least one 100-watt lamp, one can see that the potential business even in this direction is considerable. The lighted poster is a great attraction, and enables the poster to be used for many hundreds of hours more each year. Posters are usually lighted by means of angle-type reflectors, but occasionally by means of floodlights.

In brightly lighted districts a 200-watt lamp per 16-sheet poster will be required to give satisfactory results. It has been stated that the average cost of showing a 16-sheet poster is approximately 1s. 8d. per week, and if electricity is reckoned at 1d. per unit it can be shown that lighting can be provided at 30 per cent. of this cost, and will extend the useful working hours of the poster by no less than 1,500 hours per annum.

Seasonal Lighting

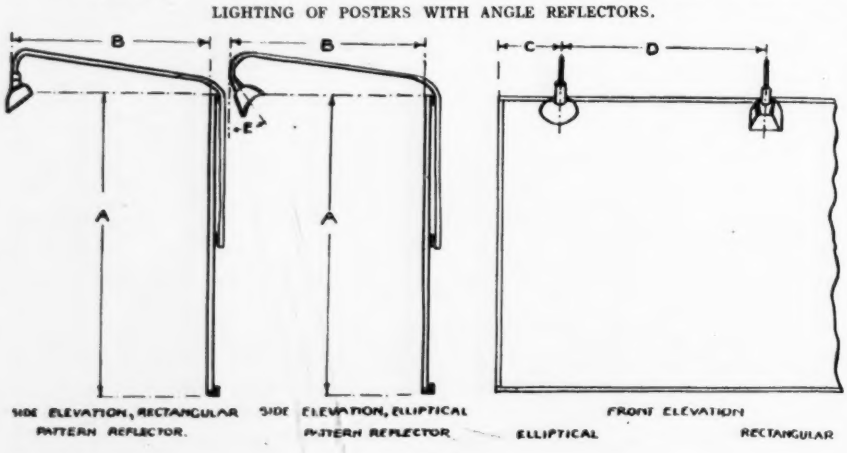
The Electrical World suggests a refinement of lighting that may well become usual in the future, namely, seasonal variations in colour effects. In the winter there is a natural desire for warmth in artificial lighting. An effect that is cosy and cheerful is preferred. Thus the approved winter lighting of the future may depend mainly on the use of mellow light, in which yellow or orange colour is predominant. This serves to emphasize the contrast between the warmth within and the coldness out of doors. On the other hand it may be argued that there is no inducement to adopt this style of lighting during a hot summer. On the contrary people may be grateful for a cooling effect; just as the householder opens his windows to the cooling breeze and supplements its action by the electric fan, so we will adopt a "cool" colour of light, approximating to that furnished by daylight. In view of the facility with which light of special colour may now be obtained, and the ease with which alternative systems of lighting can now be installed, this ideal is by no means unattainable. In particular it might be realized in restaurants and places of entertainment, which are usually quick to seize on any idea that promises to take the public fancy.

E.L.M.A. Illumination Design Courses

We recently referred to the comprehensive series of lectures being arranged by the E.L.M.A. Lighting Service Bureau at 15, Savoy Street (London, W.C.). These lectures have been given at 7-30 p.m. on Monday evenings, starting from October 10th. We understand that the response this year has been greater than ever, and that on one occasion no less than 450 engineers, representing supply, contracting and manufacturing interests attended. This may be taken as a clear indication of the general interest taken in lighting and illumination.

The course of lectures has covered a wide ground, the four during the past month dealing with floodlighting (Nov. 7th), Colour Lighting (Nov. 14th), Home Lighting (Nov. 21st) and Special Lighting Problems (Nov. 28th). The final lecture of the Autumn Series, on Dec. 5th, is devoted to a Review of Lighting Practice at Home and Abroad when such matters as research in illumination, the magnitude of the lighting market, etc., will be dealt with.

LIGHTING OF POSTERS WITH ANGLE REFLECTORS.



Size of Lamp. Watts.	"A" Height of Board.	"B" Distance of Units out From Board.	"C" Distance from end of Board.	"D" Distance Apart.	"E" Angle from Vertical.
60	2 ft.—4 ft.	3 ft. 0 ins.	2 ft. 6 ins.	5 ft. 0 ins.	17°
100	5 ft.—6 ft.	4 ft. 0 ins.	3 ft. 0 ins.	6 ft. 0 ins.	17°
150	7 ft.—8 ft.	4 ft. 6 ins.	3 ft. 3 ins.	6 ft. 6 ins.	17°
200	9 ft.—12 ft.	5 ft. 6 ins.	4 ft. 0 ins.	8 ft. 0 ins.	20°
300	13 ft.—16 ft.	6 ft. 6 ins.	5 ft. 0 ins.	10 ft. 0 ins.	20°
500	17 ft.—21 ft.	9 ft. 0 ins.	6 ft. 6 ins.	13 ft. 0 ins.	20°

American Lighting Service Methods

IN a paper read before the E.D.A. Conference at the Royal Society of Arts on October 21st Mr. W. J. Jones (E.L.M.A. Lighting Service Bureau) summarized his experiences in a recent visit to the United States. In the course of the tour New York, Chicago, Detroit, Cleveland, Schenectady, Boston and Philadelphia were visited. One of the chief features in the U.S.A. is the co-operation between different sections of the electric industry in connection with illumination. Efforts are made by central station engineers, contractors and wholesalers to foster lighting developments.

The author had an opportunity of visiting the Lighting Institute at Harrison and the School of Lighting at Nela Park, both of which correspond to the E.L.M.A. Lighting Service Bureau in this country. Both institutions are lavishly equipped. The N.E.L.A. School is in charge of a director who supervises illumination courses and arranges lectures by experts. At both institutions there is a fully equipped "electric shop," where all problems connected with shop lighting may be studied. Suggestions for display and help are given to dealers all over the country. There is a special lecture theatre to deal with industrial lighting, and equipment to demonstrate possibilities in street lighting, traffic signalling, theatre lighting, etc. In addition to the permanent lecturing staff each place has sufficient personnel to depute men to undertake specific investigations, such as improvements in methods of using light, business potentialities of various fields of lighting, the preparation of reports on specific aspects of lighting, the design of exhibition equipment for demonstrations, etc.

Advice is being continually sought from these lighting service laboratories by people from all over the country, and when any lighting matter is being considered on a national scale their experts are always consulted. Each institution is provided with apparatus for the complete testing of lighting fittings, and at Nela Park a separate department is devoted to fundamental researches. Many makers of lighting fittings consult these engineering departments before putting new fittings on the market.

The Education of Lighting Men.—Men with a knowledge of lighting are in great demand by central stations and command good salaries. The lamp companies, through their organizations, have played an important part in the education of such men, who invariably are graduates of universities or technical colleges. Several universities have special courses on illumination. For several years the institutes at Harrison and Nela Park have taken an active part in the educational programme. At Harrison 30 men were selected from colleges and paid £5 a week during the six-months lighting course. After completing their training such men pass into lighting service departments or engineering departments, to undertake investigations, surveys, etc. After two or three years many are able to fill remunerative positions with the central stations.

Activities of Central Stations.—Central stations operate on a much larger scale than is usual in this country. In Boston there is one company with 33 local offices. This consolidation of interests, as compared the numerous separate concerns in London, involves a common policy for both generation and distribution and sales promotion. In this country the Electricity Bill aims at co-ordination of generation and distribution, but hardly a common policy on development and sales. This still rests with local offices, so that there may be active development in one area and stagnation in an adjacent one.

In order to illustrate the phenomenal keenness and development of American concerns, Mr. Jones gave some particulars of the activities of the Chicago Edison Company. In Chicago proper no less than 97 per cent. of possible consumers are already on its mains. The company has 350,000 consumers and in March last sold 3½ million units. No less than 75 per cent. of the average consumption represents lighting units. 500,000 dollars are spent annually on advertising. A feature is the staff of men engaged on positive sales campaigns; it is usual for groups of men to work as teams selling lighting equipment on a deferred payment system from wagons loaded with lighting fittings. The Chicago Edison Company is now engaged on an industrial lighting campaign. Factory owners are encouraged to have their factory lighted according to a specification drawn up through the local Electrical League: 1,200 to 1,500 industrial reflectors are being sold per month.

The Philadelphia Electric Company has an equally progressive sales department. It has 453,170 consumers and last year sold 1,550,948,014 units. This concern works in close co-operation with the contractors. It undertakes complete lighting installations, prepares plans and arranges deferred-payment systems. There is a well-equipped showroom, but the company does not sell direct to consumers (except by arrangement in special campaigns) and the wiring is given to contractors. This company three years ago had a kitchen-lighting campaign. In six weeks 46,000 kitchen units were sold and even now the weekly sales are often 300 to 500. In such cases the salesman calls and asks permission to install a unit on trial, pointing out the advantages of the good illumination afforded. In seven days he calls again and endeavours to obtain a contract for its retention. It has been found that better lighting in the kitchen causes dissatisfaction with the existing lighting in other parts of the house—with the result of further new business.

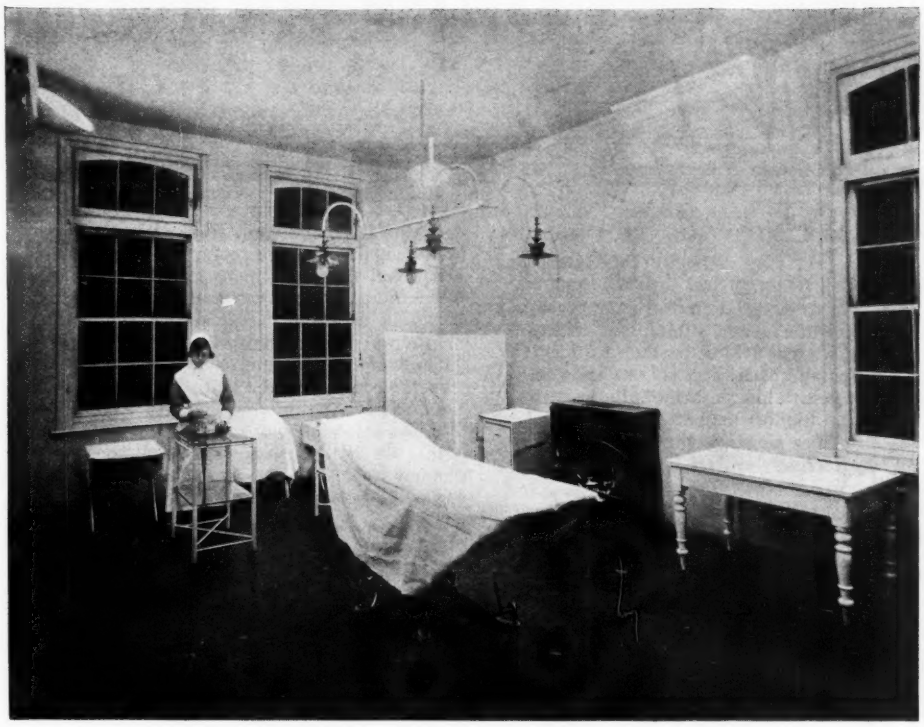
Lighting Service Departments.—The precise nature of these departments varies for different supply companies. In Chicago the department has a well-equipped laboratory, and deals with the design of lighting fittings and the preparation of lighting schemes. In Philadelphia a section of the lighting service department actually carries out valuable experimental work on such points as "The increase of production with higher illuminations," "The attracting power of the shop window," etc. By giving lighting service of genuine value to the consumer, lighting load is built up. The central station has an enormous advantage over all other interests in educating the consumer, since it is in regular touch with its consumers. In most cases it is the leader of the electrical industry in the community it serves. Statistics presented by Mr. Jones showed that whilst the lighting load formed 29·9 per cent. of the total load, the revenue from lighting forms 46·1 per cent. of the total. Central stations in America in most cases derive more than half their revenue from lighting and accordingly concentrate special efforts on increased sales.

In Boston the organization of the Lighting Service Department (which numbers about 140 members) is similarly complete. In 1910 there was only one lighting specialist; to-day there are no less than 14 fully qualified lighting experts on the staff. The Lighting Service Department prepares specifications for lighting schemes, arranges lighting exhibits and co-operates in national lighting campaigns. There is complete harmony between supply and contracting interests, and contractors often approach the department to prepare schemes on their behalf. Every care is taken to follow a job to its completion. During 1925 the Boston Edison Company increased its gross revenue by £47,860. It had three men concentrating on sign lighting and they were responsible for the erection of 677 signs. The gross revenue from this source alone was £27,000. Remarkable figures are also given for the results of their participation in the national campaign on industrial lighting in 1925-26, for which work the Boston Edison Co. was awarded the first prize of £450 offered by the National Electric Light Association in connection with this campaign.

Amongst other activities mentioned in the final portion of the paper were the preparation of a Lighting Service Manual as an aid to supply undertakings, the formation of Electrical Leagues in various parts of the country and the vast scale on which propaganda is carried out.

There can be no question of the part played by the development of illuminating engineering, and, in the final words of the author, "Lighting Service is the Key to Successful Lighting Development."

An Interesting Lighting Installation in an Operating Theatre



As is well known, the lighting of the operating theatre in a hospital offers at once a most important problem and also a somewhat difficult one. An exceptionally high illumination is required, and in this case soft shadows are particularly desirable—otherwise the body of the surgeon throws a shadow over the table and he cannot see clearly what he is doing.

We are indebted to the courtesy of The Benjamin Electric Ltd. for the above illustration, which shows a somewhat unusual method of lighting applied in the Greenwich Hospital. The consulting engineer was Mr. Stinton Jones. This theatre is now illuminated by four parabolic Benjamin reflectors, each equipped wth a 300-watt lamp. Each fitting is situated in a corner of the room 10 feet from the centre of the table and, as shown in the illustration, the reflectors are directed upwards on to the ceiling, from which they are distant about 2 feet, so that the illumination is indirect. The photograph gives a good idea of the diffusion of light, and we understand that the illumination at the centre of the table was approximately 50 foot-candles.

From the data supplied us the room appears to be approximately 200 square feet in area. The consumption is thus of the order of 6 watts per square foot, which is by no means excessive in view of the high illumination obtained.

Street Lighting and Traffic Problems

A useful point in connection with street lighting is brought out in a recent booklet issued by Messrs. Korting & Mathiesen, A.G., to who we are indebted for the use of the two illustrations below.

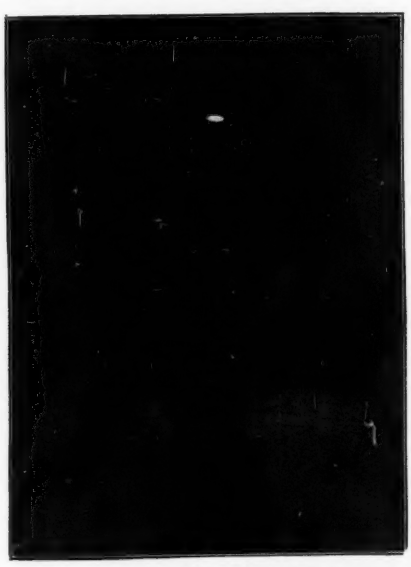


FIG. 1.—Incorrect Lighting: Lighting from above only, and only the arms and shoulders of the Officer on duty illuminated.

This is quite an incorrect arrangement as only the upper part of his arms and shoulders are illuminated; whereas it is desirable that the vertical surfaces of his body should be clearly seen by drivers, and his motions easily observed.

On the *right* (Fig 2) we see a much better form of lighting. Here light comes from many different directions and the figure can be clearly seen. This shows the advantage of diffused general lighting as compared with the local "cone of light" illustrated in Fig. 1.

The two illustrations present quite an instructive contrast.

Here we have a striking contrast. On the *left* (Fig. 1) the figure of the police officer on point duty is illuminated solely by concentrated light coming from immediately above.

FIG. 2.—Correct Lighting: The figure illuminated by light from all directions.

INTERNATIONAL ILLUMINATION COMMISSION.

DEAR SIR,

Re INTERNATIONAL ILLUMINATION COMMISSION.

With reference to " Observer's " letter on page 322 of *The Illuminating Engineer* for this month, I think it is evident that I know you, Mr. Editor, a great deal better than he does, since judging by his opening paragraph he appears to think that it is necessary for you to agree with him, either wholly or partially, before you are likely to use his letter! Personally, I am inclined to think that nothing pleases you more than an opportunity to publish a constructively critical letter with which you do not agree!

" Observer's " letter certainly comes under the category of constructive criticism, and as such must do a great deal of good. If I understand him rightly, one of his chief objections is to the transfer of the secretarial work to National Committees. In reply to this I should like to submit that in no other way is it possible for an international organization of the character of the International Illumination Commission to carry on effectively. The amount of work involved makes prompt handling by one central office quite impossible. Even assuming that there were sufficient funds to maintain such an office, the load factor would be so bad that no one could really justify such an arrangement. This, I think, has almost ceased to be a matter of opinion, and is becoming an accepted fact in other directions. Further, what experience there is would seem to show that the work when distributed among National Committees can be carried out quite effectively.

On the second point he raises it appears to me that your correspondent has slightly misunderstood the real purpose of the gatherings at Bellagio. It was, as I understand the situation, a meeting of an Executive Committee, at which opportunity was taken in addition to bring together technical committees with a view to furthering the work of the Commission. It was not a regularly organized plenary I.C.I. meeting. This is to take place next year in America, and I shall be surprised if it is not found to have very much the character indicated by your correspondent.

In the matter of the interpreters, " Observer " has put his finger on what, unfortunately, is always a difficulty at these meetings, and will continue to present a problem until English becomes generally accepted as the sole language for use at international meetings. The present use by the I.C.I. of three official languages tends to make any international meeting difficult, and the addition of a fourth, a proposal which I believe has been strongly pressed, would make it unworkable. An immediate reduction of the number to two would be a great advantage. I have had a good deal of experience of this particular difficulty, and, in my opinion, the only effective method of dealing with a meeting which is conducted in two languages is for members of one or other of the delegations to act as interpreters. Most delegations to-day include members who are sufficiently good linguists to make this procedure possible.

Another point dealt with by your correspondent is that of the long intervals between meetings. I quite agree that this is a disadvantage, but it is evident that in the case of large and comprehensive gatherings, with a good deal of social attraction added, the meetings must be held at comparatively long intervals. It would seem to me that if the meetings dealing with the different technical subjects could be held as and when these respective subjects become ripe for action, instead of waiting until all the meetings can be held simultaneously, which appears to involve a large social programme, the work would progress much more effectively. The steady penetration of agreed international industrial standards, definitions and symbols, and their growing use in international trade, thereby placing it on a more equitable basis, is likely to be a more substantial help towards maintaining the progress of the world than large social gatherings.

With regard to " Observer's " contentions that papers presented at international meetings should first be reviewed by a committee, it would, I think, be better to require that each National Committee is responsible for the quality of the papers presented by its own country, and not attempt to have an international Papers Committee. The range of subjects under consideration, and the fact that the I.C.I. deals with both scientific and industrial matters, makes it difficult to find any small group of people qualified to decide on the standard of quality necessary. I venture to hope that " Observer " is sufficiently in the counsels of the British National Illumination Committee to be in a position to state to its members what papers he considers should not have been presented at Bellagio, in order that the British National Committee may bear his remarks in mind when deciding upon the papers for presentation at the next international meeting.—Yours very truly,

P. GOOD
(British Engineering Standards Association).

SHEFFIELD ILLUMINATION SOCIETY.

On October 27th a lecture was delivered before the Sheffield Illumination Society on " The Making of an Electric Lamp," by Mr. A. E. Jepson, Branch Manager of the General Electric Co. Ltd., Sheffield.

The lecture was illustrated by numerous lantern slides and exhibits of lamps, one specially interesting feature being the 4,000-watt lamp used in lighthouses. The various processes in lamp making were described, and parts were handed round showing the various stages in production.

Mr. J. F. Colquhoun (Lighting Engineer for Sheffield Corporation) occupied the chair, and thanked the lecturer for his interesting and enjoyable address.

Experiments on the Ventilation of Small Bedrooms

By A. H. BARKER, M.Inst., C.E., B.Sc.

The aim of the Illuminating Engineering Society is to encourage all sound developments which will tend to increase the hours of sunshine in our towns and cities by the elimination or diminution of the smoke nuisance. The following is part of an interim report on some special research made in the Fuel Department of University College by Mr. A. H. Barker, Head of that Department, and will therefore be of interest to our readers.

THE report on these experiments needs a few preliminary words defining the object for which they were undertaken.

As is well known, the results of recent physiological researches have entirely altered scientific opinion as to the function of ventilation. Until a few years ago the view generally held was that the need for ventilation arose from the fact that the breathing of air produces carbonic acid vitiation, a diminution of the oxygen content of air, and other effects which were believed to make the air unfit to breathe. A supply of fresh air was regarded as necessary in order to supply new oxygen and to remove carbon dioxide.

The results of researches in this country, in Germany, and in America appear to prove that this view is erroneous, and that the true functions of ventilation are physical rather than chemical—namely, to effect the removal of the surplus body heat, and with that object to keep down the temperature and humidity, and to maintain air movement. Further objects are to reduce dust and germs, and to suppress, or diminish, smell.

Experiments have been made on the effect on rooms full of students of supplying them with entirely fresh air on the one hand, or entirely with recirculated and reconditioned air on the other—that is, by circulating the same air to the room over and over again, and on each recirculation cooling it, removing the dust, dehumidifying it, and keeping it in movement. The surprising result was secured that, as far as could be seen, there was practically no difference between the hygienic effect of reconditioned air and of fresh air at the same temperature and humidity. If there was any difference observable, the results were in favour of the reconditioned air so far as could be detected in the few weeks in which the observations were made.

The effect of these conclusions has had very undesirable reactions on the general opinion of the importance of fresh air in ventilation. They have been seized upon by some ventilating engineers to justify large reductions of both fresh air supply and heat in inhabited buildings, substituting for an adequate supply of heat and fresh air such devices as locally fixed stirring fans, punkahs, and so forth, in order to increase the cooling power.

There have been exponents of ventilation who have condemned forced ventilation altogether on the ground that it is expensive and unnecessary, and that natural ventilation by open windows can safely be substituted for it in almost all cases, especially in schools.

Various interests have advocated the total suppression of chimney flues in the bedrooms of housing schemes on the ground that a large supply of fresh air is unnecessary, and that its function may be served by a small grating leading to the outer air. It is this latter conclusion I wish especially to discuss.

However much we may agree or disagree with these extreme interpretations of the results, it will be evident that they leave the subject of ventilation, considered as a practical art or science, in a nebulous state. They do not provide us with any definite numerical standards of good ventilation, except certain doubtful figures relating to wet-bulb temperatures and Kata thermometer readings. Indeed, they seem to indicate that such standards are purely arbitrary. Physiologists of eminence have laid down at least four different factors of air which are of importance, all of which vary widely under natural weather conditions; but the human body is so adaptable to its surroundings that it is impossible to lay down any definite specification of good or bad ventilation. Constant change is said to be desirable. In investigating the effect of different room conditions, therefore, one is labouring under the great disadvantage that there are no definite standards to which to work.

I have taken a good deal of interest in the condition of an ordinary dwelling-house, as regards heating and ventilation; and I was desired by your Council to investigate from the point of view of the practical ventilating engineer, and in the light of the results of these researches, the effect of an ordinary chimney flue on the internal conditions, chemical and physical, which modern hygienists regard as criteria of good ventilation. As has been said, all these conditions are in their very nature extremely variable. Most of them are very difficult to measure accurately. It is impossible to maintain any of them constant in an ordinary room. Meticulous accuracy of observations in such conditions is merely a waste of time. These facts make a definite pronouncement in such an investigation a matter of extreme difficulty. A test, however accurately conducted, on one single occasion, or on one room, has only a small significance where the conditions may be, and almost certainly will be, altered on every future occasion on which a similar test is made.

That any short series of such experiments can be completely conclusive is obviously impossible. To make them entirely convincing, the same experiments should be repeated on many different rooms for a period not of months, but of years; and much more should be known of the ultimate physiological effect of different conditions than appears to be known at present. However, it is in the hope that a record of one such series conscientiously carried out may be of interest that I present this paper.

I hired a suitable small bedroom in a working-class house, and arranged it so that it could be used as a bedroom in a number of different conditions, both with and without a flue, and with or without either gas or electric heaters. Three persons were induced to sleep in this room under these various conditions every night for a month, and constant observations of the condition of the air in the room were taken throughout each night.

The following observations were taken at two-hour intervals throughout each night:—

(1) The carbon dioxide impurity.
(2) External and internal temperatures, wet and dry bulb.
(3) External wind movement.
(4) Internal air movement.
(5) Wet and dry Kata thermometer readings.
(6) Amount of dust.

The three persons inhabiting the room recorded their feelings each morning. In addition to this, outside observers, after a drive of several miles through the fresh air in an open car, paid regular visits early every morning to the room in which the experiments were being made, to record their impressions of the condition of the air in the room as judged by the sense of smell by a person coming straight in from the open air. It will be seen that these observations comprise most of the factors which modern hygienists regard as criteria of the perfection of ventilation.

Arrangement of Room.

The room was of 1,300 cubic feet capacity, and was provided with an ordinary fireplace connected to a 9-inch chimney about 20 feet high to the top of the chimney pot. The window (size, 6 feet by 4 feet) faced in a southerly direction. There were two walls exposed to the street, and one door, and the room contained two beds, in which three clean, healthy young men slept every night. The observations were very carefully taken, and the samples of air collected by my laboratory assistant, Mr. James Nicholls, who has been most assiduous throughout in circumstances of great discomfort.

Series I.—For the first few nights the chimney flue was completely blockd up with impermeable paper pasted over and varnished. The window was closed, the cracks were puttied up and the room made as air-tight as it conveniently could be.

The next few nights observations were made in the same conditions but with the window open 3 inches at the top, the next nights with a 6-inch opening, and a fourth with the window 12 inches open, corresponding respectively to 1, 2, and 4 square feet of free opening to the fresh air.

Series II.—The obstructions in front of the chimney flue were removed, and an exactly similar set of observations was taken with the flue open, every other condition being the same as in Series I.

Series III.—The flue was closed, and the room was warmed by a small electric stove, and the same observations were repeated.

Series IV.—The chimney flue was again opened, a small gas fire was put into the fireplace, and the observations were repeated a fourth time, everything else remaining the same. The observations were then co-ordinated and compared and plotted on diagrams.

Results of Tests.

It would be out of place in a brief descriptive paper such as this, even if it were possible, to give numerical details of this very large number of observations. They will be published elsewhere for those who are interested in such matters. I can here quote only the general results briefly, and record the impressions made upon my mind by a perfectly impartial study of them.

Series I.—(*a*) *With no heat, no chimney, and with all the apertures closed.* The carbon dioxide increased during the night from about 4 parts per 10,000 at the beginning of the night to about 27 parts per 10,000 in the early morning. This observation proves that the rate of interchange of air was in round figures about 300 cubic feet per hour per person occupying the room. The total interchange was two-thirds of one interchange per hour, in spite of all the apertures having been made as airtight as possible. This represents, of course, leakage through the ceiling, the walls, the door cracks and the like, due to the pressures induced by temperature variations. (*b*) When the window was opened 3 inches the increase of carbon dioxide during the night was from 4 to 20 parts per 10,000, giving an interchange of about once per hour, with roughly 400 cubic feet per person per hour. (*c*) With the window opened 12 inches the increase in CO_2 was from 4 to 11, showing about 2¼ interchanges per hour, or 1,000 cubic feet per person per hour.

Humidity.

In all the series the observations of the humidity (of which the figures will be given in the complete report) agreed generally with the carbon dioxide observations. That is to say, when the window, the door, and the flue were blocked up, there was a great increase of humidity as measured by the rise of the dew point and of the relative humidity. With the flue closed the window was always streaming with moisture. The rise of humidity was checked when the window was open, but was always considerable. Several of the days were wet; and in these cases the relative humidity was, of course, more pronounced still. The worst case showed well over 90 per cent. of saturation.

Observations were also made with the Kata thermometer both wet and dry. These observations agreed with the temperature and humidity figures, leaving no doubt of the substantial accuracy of the general result. In the most unfavourable conditions observed, the Kata thermometer observations showed a cooling power of rather less than 5 on Dr. Leonard Hill's scale, and the wet Kata varied from 11 to 16 in millicalories per square centimetre per hour.

The smell and closeness were very unpleasant. Indeed, with the window shut it was almost intolerable. It was less offensive the wider the window was open. All the occupants, who were accustomed to a healthier manner of life, contracted severe colds and complained each morning of headache, stuffiness, and general discomfort.

Series II.—With the flue open and the window and door shut, the rate of increase was from 4 to about 11; thus showing that, even with the window shut, the draught of the flue drew in as much air as with the window open and the flue blocked. With the window open, this figure was reduced, the decrease being approximately regular as the window was opened wider. During the later tests, the external wind, which had been previously almost still, increased considerably; and this tended to increase the interchange.

The last readings obtained with the window 12 inches open were from 5 to 6 parts per 10,000, which corresponds to an interchange of approximately 6 to 8 times per hour, and a supply of air to the occupants of about 2,700 to 3,500 cubic feet per head per hour.

The well-known smell of bedroom air was only slightly noticeable even when the window was shut. It was hardly perceptible when the window was even 3 inches open; while when it was 12 inches open it could hardly be detected at all.

Series III.—This was carried out with the flue again blocked, and a small electric fire using ½ unit per hour. The general results were similar to, but slightly better than, those of Series I. The curious effect was observed with the window open that the carbon dioxide increased to 14 parts per 10,000 in the early part of the night, and subsequently dropped to 11 parts. This effect was apparently caused by two facts:—

(1) That the gradually increasing temperature in the room increased the natural interchange.

(2) Variations in wind velocity during the night. The greater the wind velocity the greater was the interchange.

Series IV.—This was conducted in exactly the same way, but with the chimney flue open and with a small gas fire in the fireplace; the gas consumption being regulated so that the same heating effect was provided in the room as with the electric radiator. In this case the maximum recorded carbon dioxide was 8 parts per 10,000 with the window closed, giving an interchange of about 4 times. The minimum recorded with the window 12 inches open was about 4.5. The effect of the gas fire was approximately to double the interchange as compared with an open flue without a fire.

Cost.

Comparing the cost of the electric with the gas fire, the cost of the five units of electrical power used through the night was 6¼d., while the corresponding cost in gas was about 3¼d. The interchange of air with the gas fire and the window closed was 3 to 4 times that with the electric fire in use, the flue closed, and the window open 3 inches.

Dust.

These observations were taken with an Owens dust counter, which projects the dust from a measured quantity of air on to a sticky plate. This retains the dust particles, which can be subsequently counted under a microscope. The results in this case are that the amount of dust appeared to be approximately inversely proportional to the interchange of air; thus indicating that a uniform amount of dust is probably generated and distributed, and is regularly removed by the ventilation. The observations, however, were not sufficiently precise to enable this theory to be fully substantiated. Roughly speaking, it was found that there was about three times as much dust observed in the air with the flue closed as with it open—the conditions being otherwise the same.

Movement of Air.

The movement of air was taken at first by micro-anemometers—the same instruments which I designed for investigating some years ago the ventilation of the House of Commons. The readings with these instruments were found so irregular that no definite results could be obtained. I subsequently introduced streaks of ammonium chloride smoke into the room, and observed its movement with a scale and stop-watch in the usual way. It was, however, impossible to detect much difference in the results in the body of the room,

except near the firegrate and near the open window. The observations were most instructive as giving an idea of the directions of the currents; but they cannot be briefly described. It has been necessary to give these results in the briefest manner because of the short time available, and because, if they were given in detail, it would be impossible to grasp their full import by hearing them read. I will therefore arrange to publish them in full.

AN ANALYSIS OF THE RESULTS.

In analysing the results, it will be seen that the primary effect of the chimney flue is to increase greatly the rate of interchange of air in the room as compared with the same conditions in which the flue is closed.

In the case of this room, the flue increased the interchange of air between two and three times, conditions being otherwise identical. All the other observed effects are simply the consequence of the increased interchange, and could be calculated if all the factors were accurately known. These are the lowered humidity, the reduced temperature, the reduced quantity of dust, the reduced smell, and the increased Kata thermometer readings. With the flue closed, the window glass was always streaming with moisture. It was always dry with the flue open.

One very important observation was that during the time the flue was closed all the occupants suffered from colds in the head, and unanimously complained of headache—so much so that I feared daily that they would refuse to continue to sleep in the room under these conditions. This effect disappeared entirely when the flue was open. The smell of stuffy bedroom air was distinctly more noticeable to a person coming in straight from the open air when the flue was closed than when it was open. Indeed, it would have been easily possible for a blindfolded person to detect from the feeling of freshness alone, even with an open window, whether the flue had been closed or open throughout the night, by merely walking into the room and sniffing the air.

When both the flue and the window were wide open, and when there was a small gas fire in the grate, the freshness of air and the CO_2 analysis in the room were practically indistinguishable from the outer air, only the temperature being raised. It was distinctly stuffy with the flue closed, even when the window was wide open, using an electric radiator equivalent to the gas fire in heating effect.

These facts have to be considered in a practical manner in relation to the habits of the population, for it is a general custom of the poorer portion of the population to close bedroom windows because of an absurd inherited belief that there is something poisonous or deleterious in night air; possibly also for the purpose of keeping up the temperature and increasing the comfort when the bedclothes are scarce and thin.

To get an idea of what the average habits of the inhabitants of small cottages are, I made a practice of driving round in a car early every morning through many miles of streets of houses of different classes in the neighbourhood where the experiments were being made, including two of the large housing estates which the London County Council have recently erected. On some occasions I took two observers with me, one of whom counted the total number of windows on the first floor (which were presumably all bedrooms) in each street, and the other the number of the same windows which were open.

The results of these observations were striking. They showed clearly that the general habit of the population is to sleep with the windows closed, even in moderately mild weather. It was noticed that, in the rooms where blinds or curtains were drawn, very few windows were open—approximately one in twelve. These observations include not only working-class property, but also property of the better class. The time when the working-class population gets out of bed, it appears, is about 7 or 7-15, for at that time the blinds were generally drawn up. Most of the windows were opened at about 7-45 a.m. After that hour, at least half of the windows counted were open—many of them wide open.

It may therefore be concluded that, in general, the custom of the working population is to sleep with the windows closed, and to open them, if at all, only when they get up. Now if all this working-class residential property had been erected without chimney flues, it is clear that the condition of the air in the rooms would have approximated to the worst observed in my experiments.

Rent is such an important item in a working-class budget that one may be sure that all bedrooms are occupied to capacity. There will probably be in most working-class rooms at least three persons occupying every bedroom, and often more.

It is well known that if a person becomes accustomed to sleep in "fuggy" and stuffy air he does not experience any discomfort. The general experience probably is that where bedclothes are scanty in quantity (as they often are among the poorer sections of the population) it will be more comfortable to sleep with the window closed, because this causes a rise in temperature which makes the inadequate quantity of bedclothes unnoticeable, while the consequent "fugginess" of the air is not felt except by a person coming in from the outside air.

I do not believe that if the chimney flues were omitted it would result in a general opening of bedroom windows, except during warm weather. How detrimental to health it may really be to sleep constantly in a "fuggy" smell of bedroom air I am not prepared to say, or whether, and how far, a low temperature may be of advantage. These are matters for the physiologists, who, it must be confessed, do not seem to have any very definite information on the point. But it appears that unless one can reverse the opinion which has always been held that interchange of fresh air in a bedroom is a desirable condition, it is impossible to justify the construction of working-class property without flues.

I am far from saying that no bedroom without a flue can be healthy and sweet. I believe it can be, but only if the window is kept wide open. These observations have satisfied me that a bedroom with a flue, even with a closed window, is fresher than is a bedroom without a flue, but with a window slightly opened. The best of all the ventilation results is secured by an open chimney flue with a small gas fire. Even with a closed window, nothing is to be feared from the condition of the air if there is a flue. Building by-laws often specify that, if a room is built without a flue a small external grating, whose size is often specified in relation to the cubic capacity of the room, must be supplied instead. This provision is really useless, apart from the fact that the gratings are so small as to be practically without value. Any uninformed person who is cold, or who has the opinion that night air is dangerous, will always block up such an opening with newspapers or otherwise. They will also stop up by similar means an ordinary fireplace flue. The important point about the fixing of a gas fire in the grate is that it increases the difficulty of stopping up the flue.

Such are the opinions I have formed from this interesting but arduous, restless and uncomfortable series of experiments. Though they extended over about a month, they are really too short to be entirely convincing or conclusive; but the results were so definite that I believe that if the tests were extended similar results would always be secured.

Good Lighting as a Means of Preventing Accidents

We notice in *Securitas* an article by Sig. Carlo Clerici emphasizing the importance of good illumination in the interests of safety. Sig. Clerici reviews recent progress and refers to the tendency in the United States to adopt values of illumination of the order of 100 lux (10 foot-candles) for most forms of industrial work. American statistics (which it is hoped will shortly be supplemented by data obtained in Italy) suggest that quite 18 per cent. of industrial accidents are due to inadequate illumination.

TRADE NOTES & ANNOUNCEMENTS

DEVELOPMENTS IN PHILIPS LAMPS.

An attractive leaflet issued by Messrs. Philips Lamps Ltd. deals with Christmas-tree lighting sets, and makes a timely appearance. The electric candles are conveniently assembled in boxes, and are ready for immediate use. In these days electric candles play an increasing part in Christmas festivities, and have the manifest domestic advantage of saving carpets from splashes of grease.

Our attention is also drawn to a series of reflector fittings for street lighting. These are provided with a white enamelled reflector, which may be either convex or concave, and a set-screw is provided for lamp adjustment. Units are designed either for wide distribution of light or concentrating effect, and a special feature is the use of the Argenta opal lamp, which, owing to its soft effect, should be of material assistance in avoiding glare in street lighting. In the list before us industrial and semi-indirect units are also illustrated. We notice an ingenious and original "Philux" canopy for use with Argenta lamps and a description of the Philips foot-candle meter, which is a very compact and portable instrument capable of being carried in the pocket and permitting measurements of 1 to 45 foot-candles.

A series of attractive photographs recently obtained by Messrs. Philips Lamps Ltd. included a very effective view of overhead lighting in a factory. The use of the Argenta lamps in these overhead reflectors must have contributed considerably to avoidance of glare. The interior has the appearance of being flooded with light, and as the units are high up there is a complete and unobstructed view of the room.

WESTMINSTER ELECTRIC SUPPLY CORPORATION LTD.—NEW SHOWROOMS.

We have frequently referred to the important role played by showrooms in the development of electric supply undertakings. It was therefore with great interest that we accepted an invitation to visit the new showrooms of the Westminster Electric Supply Corporation Ltd., at 112, Victoria Street.

The lighting arrangements are varied and up to date, and every opportunity of demonstrating the various domestic applications of electricity has been taken. The outside window display remains illuminated until midnight, being automatically switched off at that time. On entering, the visitor finds himself in an oak-panelled room with cornice lighting, supplemented by pendant diffusing units. Numerous electric fires are seen in operation.

One also notices an ingenious display cabinet on which typical electric lamps are mounted. Each lamp as it is switched on gives the number of hours the lamp will run for one unit. Consumers can also be interviewed in a back room, prettily furnished as a drawing-room. Downstairs there are kitchens lined with white tiles and furnished with every form of domestic electrical equipment. We were glad to notice that the lighting, by diffused ceiling units, is in keeping with the other arrangements. In this section various cooking appliances, ready for hire, are on view, and we were struck by one very neat device, a meter equipped with a special pointer which enables the cost of current energy for any simple culinary operation to be demonstrated. Another room is fitted up as a Dutch dining-room in the Tudor style, with a Dutch tiled fireplace, and the bedroom and bathroom are calculated to give an idea of the luxurious conditions which electricity can afford.

Throughout the building one notices several interesting light effects—the use of an indirect unit to illuminate the central dome, the provision of an artificial skylight, from which either "artificial daylight" or uncorrected light can be furnished, and the adoption of a special wavy glass for all windows, which reflects light falling upon it, and has quite the appearance of being illuminated from behind.

From January 1st, 1928, onwards the Company is offering very favourable terms (lighting 4½d. for the first 4,000 units and 4d. thereafter; power, 1d. a unit; cooling, ½d. a unit).

MESSRS. KORTING & MATHIESEN ELECTRICAL LTD.

New London Showrooms.

We note that Messrs. Korting & Mathiesen Electrical Ltd. are making a new departure—the opening of a new showroom at 68, Victoria Street (London, S.W.1.), where all the latest K. & M. appliances will be on view. No doubt all the latest novelties, such as the "Dia" long-burning flame arc, "Throlite" street-lighting reflectors, and the new Safety-First combined reflector and traffic device will be on view, as well as the Kandem electrical meters and other electrical equipment.

We are also informed that Messrs. Korting & Mathiesen Electrical Ltd. are bringing out several new lines of fittings, particulars of which will be distributed very shortly. Amongst these may be mentioned a series of floodlighting units and an enamelled reflector with a distribution of light specially adapted to the illumination of hoardings and similar large vertical areas.

THE NEW G.E.C. CATALOGUE.

It is now quite a number of years since a complete single-volume G.E.C. catalogue was issued. Rapid developments in most sections of electrical engineering subsequently led to the adoption of the plan of producing the various editions separately, and publishing a four-volume catalogue. Still further developments have rendered even this a difficult proposition. Whilst separate complete sections dealing with the various departments will still be available, it has been found expedient to issue one comprehensive catalogue showing the range of the Company's products, but necessarily dealing with the various sections in an abridged form.

Even so, the catalogue is an impressive production, containing over 1,000 pages. Of chief interest to our readers is Section VI, dealing with fittings, fixtures and glassware. But the plan on which the whole catalogue is arranged is convenient, and a little familiarity will enable users to find any article they require. Special features include glossary, wiring specifications, conversion tables, and other useful data. There is also a very complete index arranged both alphabetically and numerically, and blank pages are inserted at the end of each section for the purpose of making notes.

In issuing this catalogue the General Electric Co. Ltd. remind users that even the most complete catalogue should be supplemented by actual display and demonstrations. Accordingly, a cordial invitation is issued to those interested to visit either the well-known showrooms at Magnet House, Kingsway, or one of the various branches (20 in number) distributed throughout Great Britain and Ireland.

OSRAM LIGHTHOUSE LAMPS IN LORD MAYOR'S SHOW.

An interesting item in the Trinity House tableau in the Lord Mayor's Show was the opportunity afforded to Londoners of observing something of the working of lighthouses, and, incidentally, the important part played by Osram lamps in the provision of warning beacons for the protection of the coasts of Britain.

Two 80-volt 4,000-watt models of these lamps were prominently displayed, each being larger than a full-size football, and as these were products of the Osram Lamp Works at Hammersmith, it is only natural that Londoners observed them with a large amount of pride.

We also understand that Osram lamps again played a part in connection with Armistice celebrations in Hyde Park. It will be recalled that a great overflow singing festival was organized by the London *Daily Express* in the park on Armistice Day, and the band of H.M. Irish Guards led the assembly in choral numbers. The electric lighting of the platform, band and public enclosure was effected by means of G.E.C. Wembley lanterns equipped with 1,500 Osram gasfilled lamps. These units were mounted on masts 25 feet high, and spaced at intervals of 90 feet.

LIGHTING DEVELOPMENTS IN SOUTH AMERICA.

Not very much is heard about developments in illumination in South America, but there is no doubt that an important field for experts exists in such countries as the Argentine, Chile and Brazil, where there are many prosperous and rapidly extending cities. Our attention is drawn to these possibilities by a perusal of the special International Conference issue of *Holophane Illumination*, to which we referred some time ago. Several striking Holophane street-lighting installations are described. Amongst these we may mention the imposing installation of Holophane refractors in the wide Avenida Sarmiento in Buenos Ayres. Another similar installation is in the Avenida de Mayo in the same city, where refractors have been installed on a large scale and central 5-light standards employed. Perhaps the most noteworthy street-lighting installation, however, is that in the city of Santiago (Chile), where no less than 10,000 Holophane Dome Refractors, enclosed in ornamental lanterns, have been adopted. Two such lanterns are mounted on each standard in localities where specially high illumination is desired, and the installation has attracted a considerable amount of attention in South America. These examples illustrate the tendency towards decorative street-lighting units in American cities; where the directive qualities of the refractor are combined with a diffusing lantern the effect is quite imposing.

SIEMENS ELECTRICAL DOMESTIC APPLIANCES.

Catalogue No. 180, dealing with "Xcel" domestic electric appliances and issued by Messrs. Siemens Electric Lamps and Supplies Ltd., should be of considerable interest as it covers a wide field. This list is concerned with heating and cooking appliances, which in many cases are illustrated in colour. Full constructional details are given and many varied devices (electric ranges, boiling plates, kettles, towel rails, etc.) are shown. Special interest attaches to the "Xcel tube-heating system by means of low-temperature electrical convectors, which have many applications, for example, in ships, garages and shop windows.

"EMVEE" WIRING ACCESSORIES.

Another useful list is that devoted to "Emvee" Wiring Accessories (Section B) which is issued by Metro-Vick Supplies Ltd. The special "Emvee" lampholder is fully illustrated, and many types of special switches (rotary switches, time switches, etc.), are included. A very useful and neat device is the interlocked rotary switch plug, but there are others which also serve to show how greatly the design of electrical accessories has improved during recent years. Whilst not primarily devoted to lighting, the list contains an account of "Emvee" shop-window lighting reflectors, which are now made in a variety of types.

PERSONAL.

We take this opportunity of recording the transference of Mr. W. Millner to the staff of the Westminster Electric Supply Corporation, with whom he has now been engaged for some months. Mr. Millner was previously associated with the illuminating engineering department of The British Thomson-Houston Co. Ltd., and it will be recalled that he was one of those who contributed to the discussion on "Problems in Illuminating Engineering" before the Illuminating Engineering Society last session. We congratulate the Corporation on adding to their staff someone who is familiar with the principles of illuminating engineering, and we hope that their example will be followed by other electric supply undertakings.

BENJAMIN PROGRESS.

In our last issue reference was made to the new Benjamin catalogue. This is briefly described in the latest issue of *The Benjamin Reflector*, in which the great extension of the factory at Tottenham is illustrated. A view is reproduced showing the additions to floor space, which has been more than doubled, and will occupy an area of over 50,000 square feet. We hope to have an opportunity shortly of referring more fully to this development.

CONTRACTS CLOSED.

The following contracts are announced :—

SIEMENS ELECTRIC LAMPS AND SUPPLIES LTD. :

Great Western Railway Co.; for vacuum, gasfilled and train-lighting lamps.

REVIEWS OF BOOKS AND PUBLICATIONS RECEIVED

OFFICIAL YEAR-BOOK OF THE BRITISH OPTICAL ASSOCIATION. (*Published by the British Optical Association at Clifford's Inn, London, E.C.*, 1927; *pp.* 507.)

This year-book is quite an imposing publication. Following a list of officers and a brief statement of aims and objects there is a general account of the activities of the Association, which was formed in February, 1895, and finally incorporated in November, 1899. There is next presented a catalogue of the Clifford's Inn Library, which has recently been enriched by a combined grant of £2,000 from the Carnegie Trust and the Association. The list of works is certainly a comprehensive one, and we imagine that there are few, if any, libraries on optical work in this country which could compete. The Association now numbers over 1,000 members.

Other items include a report of a visit recently paid by delegates of the Association to certain works and institutions in Germany and an account of the examinations prescribed by the Association for opticians. Typical examination papers (which include tests of knowledge of foreign languages) are reproduced. At the conclusion of the booklet the memorandum, the petition for the granting of a charter and the draft of the charter proposed, are reproduced. Finally there are reproductions of specimen pages from *The British Journal of Physiological Optics*.

SAFETY RULES FOR THE INSTALLATION AND MAINTENANCE OF ELECTRICAL SUPPLY AND COMMUNICATION LINES. (*Handbook of the Bureau of Standards* (*Washington*), *No.* 10; *pp.* 322.)

We have received a copy of the above very useful handbook, which may be commended to the attention of electrical engineers in this country. We hope to refer to this more fully shortly.

MODERN PICTURE THEATRE ELECTRICAL EQUIPMENT AND PROJECTION; *by R. V. Johnson.* (*Crosby, Lockwood & Sons, London*, 1927; *second edition; pp.* 188, *figs.* 88.)

This edition of Mr. Johnson's manual has been considerably enlarged, one new feature being the discussion of water supply. The author aims at presenting general information on picture-theatre equipment in a practical form, and the book covers a wide range. The generating plant, projecting apparatus, intake chamber, etc., are described, and hints are given on management of dynamos and motors and care of apparatus. Something is also said on the subject of auditorium and outside lighting, special reference being made to the use of colour. The book is illustrated by many views of modern projectors and appliances.

THE IDEAL KINEMA (*Supplement to "The Kinematograph Weekly, November*, 1927).

This supplement is described as "a record of modern practice in kinema erection, equipment, furnishing and decoration." It is fully illustrated, and contains a considerable quantity of interesting matter. The first article, by Mr. Robert Atkinson, F.R.I.B.A., deals with the Architect's Problem. Mr. J. R. Leathart discusses the Provincial Kinema, and Mr. Hope Bagenal deals with Acoustics. Specially interesting is the contribution by Mr. Clough Williams-Ellis on "Atmospheric Decoration." Stage-lighting equipment is dealt with by Mr. H. Lester Groom and Kinema Lighting by Mr. C. Sylvester. The whole series of articles is of interest as showing the trend of modern ideas on kinema design and decoration and the increasing importance attached to supplements to the film, such as colour and music.

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